Department: Computer Science and Engineering (Cyber Security)

Vision of the Department

"To ignite a passion for innovation in Computer Science and Cybersecurity, empowering students to become leaders who shape a secure and interconnected future"

Mission of the Department

- To provide an exceptional educational experience fostering critical thinking, creativity, and a deep understanding of cybersecurity principles.
- To equip graduates with in-demand skills and an ethical mindset to thrive in the dynamic cybersecurity landscape.
- To cultivate a collaborative learning environment connecting students with industry experts, cutting-edge research, and real-world challenges.
- To inspire a lifelong commitment to learning and dedication to building a safer, more secure digital world.

Program Educational Objectives (PEOs)

- Excel as innovative technical leaders in computer science and cybersecurity, developing secure and robust solutions.
- Demonstrate a strong ethical mindset and contribute positively to a safer digital world.
- Show a continuous commitment to professional growth and actively engage with industry and research.

- To work efficiently in multi-disciplinary teams to establish good soft skills to prove themselves at IT sector.

Program Outcomes (POs)

1. **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
2. **Problem Analysis**: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
3. **Design/Development of Solutions**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
4. **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
5. **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
6. **The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
7. **Ethics**: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
8. **Individual and Collaborative Team work**: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
9. **Communication**: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation,

make effective presentations considering cultural, language, and learning differences

10. **Project Management and Finance**: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and a leader in a team, and to manage projects and in multidisciplinary environments.
11. **Life-Long Learning**: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

Program Specific Outcomes (PSOs)

1. Able to apply appropriate techniques for storage of huge amount of data and ensuring its integrity.
2. Choose appropriate method for data acquisition from real world and propose suitable solutions to solve problems.

Scheme of Teaching and Examination-2022 (160 Credits Scheme, NEP)

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

III Semester B.E.

Academic year: 2025-26

Sl No.	Course Code		Course Title	Teaching Dept.	Teaching Hrs.					Credits	Examination			
					L	T	P	S	Total		CIE	SEE	Total Marks	Exam Hrs
01	BS	22SS301	Statistics and Probability	MA	42	-	-	48	90	3	50	50	100	3
02	PC	22CY302	Cyber Security Essentials	CY	42	-	-	48	90	3	50	50	100	3
03	PC	22CY303	Embedded System design and IOT	CY	42	-	28	50	120	4	50	50	100	3
04	PC	22CY304	Data structures	CY	42	-	28	50	120	4	50	50	100	3
05	PC	22CY305	Operating System	CY	42	-	-	48	90	3	50	50	100	3
06	PC	22CY306	Dept. Skill Lab - I (Python lab)	CY	14	-	28	18	60	2	50	50	100	3
07	HS	22SK307	Skill Development-1	T&P	-	-	28	2	30	1	50	-	50	-
08	HS	22HS308	Constitution of India	HS	14	-	-	16	30	1	50	-	50	-
L-Lecture, T-Tutorial, P-Practical, /Drawing, CIE-continuous Internal Evaluation, SEE-Semester End Examination, S- Self Study				**Total**	**238**	**0**	**112**	**280**	**630**	**21**	**400**	**300**	**700**	**-**
Credit Distribution: BS: Basic Science-03, PC: Professional Core-16, HS: Humanity Science-02, **Total=21 Credits.**														

Department: MATHEMATICS			Semester:	III
Subject: Statistics and Probability (Common to AI&ML, CR CS, DS and IS)				
Subject Code:	22SS301	L – T – P - S:	42-0-0-48 (In Hrs)	
			Credits:	3

Sl. No.	Course Objectives
1	**Introduce** the concept of correlation and regression and fitting of a curve.
2	**Apply** discrete and continuous probability distributions for single and two variables in analyzing the probability models arising in engineering field.
3	To **understand** the concepts of the stochastic process of a statistic and estimation of parameters
4	**Develop** analytical capability and to impart knowledge of Probability, Statistics and Queuing

Module	Description	Hrs
I	**Statistical Methods:** Correlation and regression- Karl Pearson's coefficient of Correlation, Regression analysis- lines of regression (without proof), rank correlation, problems. **Curve fitting:** Curve fitting by the method of least squares- Fitting of the straight line, second degree parabola and exponential form of the curve $y = ab^x$ (All results without proof) –Problems. **Text book 1:** Module-I: 25.7,25.12 to 25.14,24.5,24.6,24.8	**08**
II	**Probability Distributions:** Review of basic probability theory. Random variables (Discrete and Continuous), Probability of mass/density functions, Binomial distribution, Poisson's distribution, Exponential distribution and Normal distribution (without derivations) and problems. **Text book 1:** Module-II:26.7 to 26.9,25.26.14 to 26.16 **Text Book 2:** Module-II:2.1,2.2,2.3	**08**
III	**Joint probability distributions**: Joint probability distribution for discrete random variables, Mathematical expectations, Covariance and Correlation.	**08**

	Analysis of variance: Definition and properties, one way classification, verification within and between treatments. **Text Book 2:** Module-III:2.5	
IV	**Markov Chain:** Probability Vector, Stochastic Matrix, Regular Stochastic Matrix, definition of Markov Chain, Transition Probabilities and Transition probability Matrix, Higher Transition Probabilities, state transition diagram, stationary distribution of regular Markov chains, problems. **Queuing theory**: Introduction, Concepts and M/G/1 and M/M/1 queuing systems, problems. **Text Book 2:** Module-IV:4.1,8.1	**09**
V	**Sampling and Statistical Inference:** Sampling distributions, Concepts of hypothesis, standard error and confidence interval, Type-1 and Type-2 errors, Level of significance, One tailed and two tailed tests. Z-test: for single mean, for single proportion. Student's t – distribution, Chi-square test for goodness of fit. **Text book 1:** Module-V:27.2 to 27.17 **Text Book 2:** Module-V:11.6	**09**

Text books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	Higher Engineering Mathematics	B.S. Grewal	44th Edition Khanna Publications, 2021.ISBN:9788193328491
2	Introduction to Probability Models	Sheldon M. Ross	Elsevier, 9th Edition, 2007

Reference Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	Probability, Random variables and Stochastic Process	Athanosios Papoulis & S. Unnikrishna Pillai	Tata McGraw Hill, 4th edition, 2002

2	Higher Engineering Mathematics	B.V.Ramana, Tata McGraw-Hill	11th Edition, Tata McGraw-Hill, 2017, ISBN:9780070634190
3	Statistics Random Processes & Queuing Theory	B.Prabha, P.S. Arunachalum, R. Sujatha	Scitech Publications,2003

Course Outcomes:

CO1	**Understand** the concepts of Curve Fitting, Correlation, Regression, probability distribution and Markov chain.
CO2	**Formulate** and solve mathematical problems on probability distribution, sampling theory, queuing theory and analysis of variance.
CO3	**Analyze** the behavior of Markov chain-based problems in the long run and compute the correlation, regression lines, covariance of random variables using joint probability.
CO4	**Apply** the concepts of Analysis variance, testing of hypothesis, Markov chain, Probability distributions and queuing theory models in engineering fields.
CO5	**Analyze** the concepts of testing of hypothesis, Markov chain, Probability distributions and queuing theory models in solving engineering problems.

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2											
CO2	3	2	1										
CO3	3	3	2								1		
CO4	3	3	2	1							1		
CO5	3	2		1							1		

Department: CSE (Cyber Security)			**Semester:**	**III**
Subject: Cyber Security Essentials				
Subject Code:	**22CY302**	**L – T – P –S:**	**42 – 0 – 0 – 48**	
			Credits:	**3**

Sl. No.	**Course Objectives**
1	To **Interpret** various types of cyber-attacks and cyber-crimes
2	To **learn** threats and risks within context of the cyber security and cyber forensics
3	To **study** the defensive techniques against these attacks
4	To **understand** various cyber security privacy issues.

Module	**Description**	**Hrs**
I	**Introduction to Cyber Security:** Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, Internet Governance – Challenges and Constraints, Computer Criminals, CIA Triad, Assets and Threat, motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., Comprehensive Cyber Security Policy. **Textbook1:** Ch1,2 **Ref. Textbook:** Ch 1	**07**
II	**Cyberspace and the Law & Cyber Forensics**: Introduction, Cyber Security Regulations, Roles of International Law. The INDIAN Cyberspace, National Cyber Security Policy. Introduction, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics **Textbook1:** Ch3 **Ref. Textbook:** Ch 8,9	**09**
III	**Cybercrime: Mobile and Wireless Devices:** Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era,	**09**

	Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Organizational security Policies and Measures in Mobile Computing Era, Laptops. **Textbook1**: Ch 6 **Ref. Textbook:** Ch 5	
IV	**Cyber Security:** Organizational Implications**:** Introduction, cost of cybercrimes and IPR issues, web threats for organizations, security and privacy implications, social media marketing: security risks and perils for organizations, social computing and the associated challenges for organizations **Textbook1:** Ch 7 **Ref. Textbook:** Ch 7	**08**
V	**Privacy Issues**: Basic Data Privacy Concepts: Fundamental Concepts, Data Privacy Attacks, Data linking and profiling, privacy policies and their specifications, privacy policy languages, privacy in different domains- medical, financial, etc **Textbook1:** Ch 9 **Ref. Textbook:** Ch 4	**08**

Text Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	Cyber Security Understanding Cyber Crimes	Nina Godbole and Sunit Belpure	Computer Forensics and Legal Perspectives, Wiley ISBN 13 - 9780070701984
2	Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives	B.B. Gupta, D.P. Agrawal, Haoxiang Wang	CRC Press, ISBN 9780815371335,2018.

Reference Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	Cyber Security Essentials	James Graham, Richard Howard	CRC Press.

		and Ryan Otson,	
2	Introduction to Cyber Security	Chwan-Hwa(john) Wu,J. David Irwin	CRC Press T&F Group

Course Outcomes:

Course outcome	Descriptions
CO1	**Analyze** and evaluate the cyber security needs of an organization
CO2	**Understand** Cyber Security Regulations and Roles of International Law.
CO3	**Design** and develop a security architecture for an organization
CO4	**Understand** fundamental concepts of data privacy attacks
CO5	**Apply** cybersecurity principles, privacy policies, and defensive measures to protect organizational and personal digital assets.

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2					3		3					
CO2		2		2		3							
CO3	2	2	3	3	2	2							
CO4	1					2							
CO5	2	2	2	3	3	3							

Department: CSE (Cyber Security)	Semester:	III

Subject: Embedded Systems and IoT (Integrated course)				
Subject Code:	22CY303		L – T – P - S:	42-0-28-50 (In Hrs)
			Credits	4

Sl. No.	Course Objectives
1	To **learn** the internal architecture and programming of an embedded processor.
2	To **introduce** interfacing, I/O devices to the processor.
3	To **introduce** the evolution of the Internet of Things (IoT).
4	To **build** a small low-cost embedded IoT system using Arduino/Raspberry Pi/ open platform.

Unit	Description	Hrs.
I	8-Bit Embedded Processor: 8-Bit Microcontroller, Architecture, Instruction Set and Programming, Programming Parallel Ports, Timers and Serial Port, Interrupt Handling. **Textbook 1:** Ch 1, 2, 3, 4 **Ref. Book 2** – Ch 1, 2	**08**
II	**Embedded C Programming:** Memory And I/O Devices Interfacing, Programming Embedded Systems in C, Need For RTOS, Multiple Tasks and Processes Context Switching, Priority Based Scheduling Policies **Textbook 1**: Ch 5, 6 **Ref. Book 1** – Ch 2, 3	**08**
III	**Iot And Arduino Programming**: Introduction to the Concept of IoT Devices, IoT Devices Versus Computers, IoT Configurations, Basic Components, Introduction to Arduino, Types of Arduinos, Arduino Toolchain, Arduino Programming Structure, Sketches, Pins – Input/Output from Pins Using Sketches, Introduction to Arduino Shields, Integration of Sensors and Actuators with Arduino. **Textbook 2**: Ch 1, 2 **Ref. Book 1 –** Ch 2, 3	**09**
IV	**Iot Communication and Open Platforms:** IoT Communication Models and APIs, IoT Communication Protocols, Bluetooth, Wi-Fi ZigBee, GPS, GSM modules, Open Platform (like Raspberry Pi),	**09**

	Architecture Programming, Interfacing, Accessing GPIO Pins, Sending and Receiving Signals Using GPIO Pins, Connecting to the Cloud **Textbook 2:** Ch 3, 4 **Ref. Book 3 –** Ch 4, 5	
V	**Applications Development:** Complete Design of Embedded Systems Development of IoT Applications, Home Automation, Smart Agriculture, Smart Cities Smart Healthcare. **Textbook 2:** Ch 5, 6 **Ref. Book 3 –** Ch 6, 7	**08**

LAB CONTENT

Sl. No.	Experiment Description
1	(i) Write 8051 Assembly Language experiments using simulator. (ii) Test data transfer between registers and memory. (iii) Perform ALU operations.
2	Write Basic and arithmetic Programs Using Embedded C.
3	Introduction to Arduino platform and programming
4	Explore different communication methods with IoT devices (Zigbee, GSM, Bluetooth)
5	Introduction to Raspberry PI platform and python programming
6	Interfacing sensors with Raspberry PI
7	Communicate between Arduino and Raspberry PI using any wireless medium
8	Setup a cloud platform to log the data
9	Setup a cloud platform to log the data
10	Design an IOT based system

Text Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	The 8051 Microcontroller and Embedded Systems”	Muhammed Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay	Pearson Education, Second Edition, 2014

2	"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things".	Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro	CISCO Press, 2017.

Reference Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	Michael J. Pont, "Embedded C", Pearson Education, 2007.	Robert Kruse, C L Tondo, Bruce Leung, ShashiMogalla	PHI, 2nd Edition, 2015,ISBN13: 978-0132883665.
2	"Computers as Components: Principles of Embedded Computer System Design"	Wayne Wolf	Elsevier, 2006
3	"Arm System Developer's Guide",	Andrew N Sloss, D. Symes, C. Wright	Morgan Kauffman/ Elsevier, 2006.
4	"Internet of Things – A hands-on approach"	Arshdeep Bahga, Vijay Madisetti	Universities Press, 2015

Course Outcomes:

Course outcome	Descriptions
CO1	**Explain** the architecture of embedded processors.
CO2	**Design** simple embedded applications and ability to write embedded C programs.
CO3	**Compare** the communication models in IOT.
CO4	**Design** IoT applications using Arduino/Raspberry Pi /open platform
CO5	**Integrate** embedded systems and IoT technologies to develop functional prototypes for real-world applications.

Course Articulation Matrix:

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1											
CO2	2	3	2	3									
CO3	2	2	3	2									
CO4		2	3	2		2					2		
CO5	3	3	3	3	2	2							

Department: CSE (Cyber Security)	Semester:	III

Subject: Data Structures				
Subject Code:	22CY304	L – T – P - S:	42-0-28-50 (In Hrs)	
			Credits	4

Sl. No.	Course Objectives
1	To **provide** the knowledge of basic data structures and their implementations.
2	**Define** and **analyze** the concepts of Linear & Non-Linear Data Structures.
3	To **understand** importance of data structures in context of writing efficient programs.
4	To **develop** skills to apply appropriate data structures in solving real world problems.

Module	Description	Hrs
I	**Pointers and Structures revisited, Stacks and its applications:** Pointers and Structures revisited: accessing variables through pointers, passing pointers to a function, pointers to pointers, array of pointer, memory allocation functions,. Structure definition and declaration, Types of structures. Stacks: Definition and Examples, Representing Stacks in C. Example: infix, postfix and prefix: basic definitions and examples, evaluating a postfix expression with program, converting an expression from infix to postfix with program. Recursion: binary search and towers of Hanoi. **Textbook 1:** Ch 1, 2, 3 **Textbook 2:** Ch 1, 2 Ref. Book 1 – Ch 2, 3	**08**
II	**Queue, Circular queue and Priority queue:** Queues: The Queue and its Sequential Representation, C implementation of Queue. Circular Queue, and The priority queue – Array implementation of priority queue. Ref. Book 1 – Ch 7, 8 Ref. Book 1 – Ch 4	**08**

III	**Singly Linked List, Circular Singly Linked List:** Inserting and removing nodes from a list, Header nodes, Array implementation of lists, limitations of array implementation. Linked implementation of Stack, linked implementation of queue. Circular lists: primitive operations on circular list. **Textbook 1:** Ch 5 **Textbook 2:** Ch 4 Ref. Book 1 – Ch 5	**09**
IV	**Doubly linked list, Circular Doubly linked list:** Doubly linked lists: Inserting and removing nodes from a double linked list. Primitive operations on circular doubly linked list. **Textbook 1:** Ch 6 Ref. Book 1 – Ch 6	**09**
V	**Trees:** Basic tree concepts: Terminology, tree representation, Binary trees: properties, binary tree structure. Binary tree traversals: Tree traversal techniques: preorder, inorder and post order, Expression trees: infix, postfix and prefix traversal. General trees: Changing general tree to binary tree, insertion into general trees. Textbook 1: **Ch 8** Ref. Book 1 **– Ch 7, 8**	**08**

LAB CONTENT:

	Experiment Description
1	Write a C program to construct a stack of integers and to perform the following operations on it: a. Push b. Pop c. Display The program should print appropriate messages for stack overflow and stack underflow
2	Write a recursive C programs for the following: a. Searching an element on a given list of integers using the binary search method. b. Solving the Towers of Hanoi problem.
3	Write a C Program to convert and print a given valid parenthesized infix expression consists of single character operands and the binary operators + (plus), - (minus), * (multiply) , /(divide) to suffix / postfix expression.
4	Write a C program to evaluate a valid suffix / postfix expression using stack. The suffix / postfix expression is read as a non-negative single digit operands and binary operators + (plus), - (minus), * (multiply) , /(divide)
5	Write a C program to simulate the working of a Queue of integers using an array. provide the following operations: a. Insert b. Delete c. Display The program should print appropriate messages for Queue full and Queue empty
6	Write a C program to simulate the working of a Circular Queue of integers using an array. Provide the following operations: a. Insert b. Delete c. Display The program should print appropriate messages for Circular Queue full and Circular Queue empty
7	Write a C program to simulate the working of a Priority Queue of integers using an array. Provide the following operations: a. Insert b. Delete c. Display.
8	Write a C program using dynamic variables and pointers, to construct a Singly Linked List consisting of the following information in each node: student ID (integer), student name (string) and semester (integer). The operations to be supported are: a. The insertion operation: i. At the front of a list ii. At the back of the list iii. At any position in the list b. Deleting a node based on student id. c. Searching a node based on student id and update the information content. d. Displaying all the nodes in the list. (Note: Only either (a, b and d) or (a, c and d) may be asked in the examination).

9	Write a C program using dynamic variables and pointers, to construct a Doubly Linked List consisting of the following information in each node: student ID (integer), student name (string) and semester (integer). The operations to be supported are: a. Create a doubly linked list by adding each node at the front. b. Insert a new node to the left of the node whose key value is read as an input c. Delete the node of a given data, if it is found, otherwise display appropriate message. d. Display the contents of the list. (Note: Only either (a, b and d) or (a, c and d) may be asked in the examination).
10	Write a C Program to a. Construct a binary search tree of integers. b. Traverse the tree using inorder, preorder and postorder methods. c. Display the elements in the tree.

Text Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	Data Structures: A Pseudocode Approach with C	Richard F. Gilberg and Behrouz A. Forouzan	Second Edition, Cengage publication, 2007, ISBN- 13: 9788131503140
2	Data Structure using C	Aaron M. Tenenbaum, Yedidyah Langsam and Moshe	Data Structure using C

Reference Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	Data Structures and Program Design in C	Robert Kruse, C L Tondo, Bruce Leung, ShashiMogalla	PHI, 2nd Edition, 2015, ISBN13: 978-0132883665.
2	Data Structures	Seymour Lipschutz	McGraw Hill publications, 2018, ISBN-13:978-0-070198-4

Course Outcomes:

Course outcome	Descriptions
CO1	**Understand** the basic data structure operations and analyze the time and space complexity of searching algorithms
CO2	**Develop** algorithms using the basic operations of stacks and queues and analyze their complexity
CO3	**Implement** the basic operations of linked lists and analyze their algorithm complexity.
CO4	**Identify** the basic terminologies and operations on binary trees, binary search tress, AVL trees and B+ trees
CO5	**Compare** the performance different algorithms in term of Space and Time complexity

Course Articulation Matrix:

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1											
CO2	2	3	2	3									
CO3	2	2	3	2									
CO4		2	3	2		2					2		
CO5	2	2	2										

Department: CSE (Cyber Security)			**Semester:**	**3**
Subject: Operating Systems				
Subject Code:	**22CY305**	**L – T – P - S:**	**42-0-0-48 (In Hrs)**	
			Credits:	**3**

Sl. No.	Course Objectives
1	To **explain** main components of OS and their working
2	To **familiarize** the operations performed by OS as a resource Manager
3	To **impart** various scheduling policies of OS
4	To **teach** the different memory management techniques.

Module	Description	Hrs
I	**Operating Systems Overview:** Introduction, operating system operations, process management, memory management, storage management, protection and security, distributed systems. **Operating Systems Structures:** Operating system services and systems calls, system programs, operating system structure, operating systems generations. **Textbook 1: Ch1,2** **Ref. Book 1 – Ch 1, 2**	**08**
II	**Process Management:** Process concepts, process state, process control block, scheduling queues, process scheduling, multithreaded programming, threads in UNIX, comparison of UNIX and windows. **Concurrency And Synchronization:** Process synchronization, critical section problem, Peterson's solution, synchronization hardware, semaphores, classic problems of synchronization, readers and writers problem, dining philosophers problem, monitors, synchronization examples(Solaris), atomic transactions. Comparison of UNIX and windows. **Textbook 1: Ch3,6** **Ref. Book 1 Ch 3, 6**	**08**

III	**Deadlocks:** System model, deadlock characterization, deadlock prevention, detection and avoidance, recovery from deadlock banker's algorithm. **Memory Management:** Swapping, contiguous memory allocation, paging, structure of the page table, segmentation, virtual memory, demand paging, page-replacement algorithms, allocation of frames, thrashing, case study – UNIX **Textbook 1: Ch 7,8,9** **Ref. Book 1 – Ch 7, 8, Ref. Book 2 – Ch 3, 4**	**09**
IV	**File System:** Concept of a file, access methods, directory structure, file system mounting, file sharing, protection. File system implementation: file system structure, file system implementation, directory implementation, allocation methods, free-space management, efficiency and performance, comparison of UNIX and windows. **Textbook 1: Ch 10,11** **Ref. Book 1 – Ch 11, 12**	**08**
V	**I/O System:** Mass storage structure - overview of mass storage structure, disk structure, disk attachment, disk scheduling algorithms, swap space management, stable storage implementation, tertiary storage structure. I/O: Hardware, application I/O interface, kernel I/O subsystem, transforming I/O requests to hardware operations, streams, performance **Textbook 1:Ch 10,11** **Ref. Book 1 – Ch 11, 12**	**09**

Text Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	Operating System Principles	Abraham Silberschatz, Peter Baer Galvin, Greg Gagne (2006)	7th edition, Wiley India Private Limited, New Delhi.

Reference Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	Operating Systems, Internals and Design Principles	Stallings (2006),	5th edition, Pearson Education, India.
2	Modern Operating Systems,	Andrew S. Tanenbaum (2007),	2nd edition, Prentice Hall of India, India.
3	Operating systems,	Deitel & Deitel (2008),	3rd edition, Pearson Education, India

Course Outcomes:

Course outcome	Descriptions
CO1	**Outline** various concepts and features of Operating systems.
CO2	**Compare** various operating systems with respect to characteristics and features
CO3	**Implement** algorithm of CPU Scheduling, Memory Scheduling and disk scheduling
CO4	Make changes in the OS configurations as per need.
CO5	**Apply** operating system concepts to optimize system performance and manage resources effectively.

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1											
CO2	2	3	2	3									
CO3	2	2	3	2									
CO4		2	3	2		2					2		
CO5	3	3	3	3	2	2							

Department: CSE (Cyber Security)	Semester:	III

Subject: Dept. Skill Lab - I (Python Lab)				
Subject Code:	22CY306		L – T – P - S:	14-0-28-18
			Credit	2

Sl. No.	Course Objectives
1	**Understand** the purpose and practical application of various Python programming constructs
2	**Explore** the operational principles of various Python data structures
3	**Gain** hands on experience on using Python Libraries for efficient data manipulation, analysis and visualization
4	**Understand** the purpose and practical application of various Python programming constructs

LAB CONTENT:

Sl. No.	Experiment Description
Minimum of two lab exercises have to be conducted on each of the following topics and the students have to submit case studies by integrating all the concepts	
1	Python Data Types, Operators and Expressions Conditionals and Iterations Functions and Modules Strings and Tuples
2	Lists, Dictionaries and Sets File handling Exception Handling
3	NumPy Arrays: Creating NumPy Arrays Array Indexing Reshaping Arrays Array Math Array Assignment Manipulating Tabular Data using Pandas: Pandas Series Pandas Data Frame Data Visualization using Matplotlib and Seaborn: Plotting Line Charts

	Plotting Bar Charts Plotting Pie Charts Plotting Scatter Plots Plotting Using Seaborn

Course Outcomes:

Course outcome	Descriptions
CO1	**Demonstrate** expertise in handling various Python programming constructs
CO2	**Identify** and use appropriate data structures for efficient data representation and access
CO3	**Develop** Python scripts to analyze and visualize datasets
CO4	**Identify** and use appropriate data structures for efficient data representation and access
CO5	**Develop** python scripts to analyze and visualize datasets.

Course Articulation Matrix:

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1												
CO2	1	3			1								
CO3	1	3			1			2	2				
CO4	1	2	3										
CO5	2	2	3	2									

Department: CSE (Cyber Security)			Semester:	III
Subject: Skill Development-I (Communication and Soft Skills)				
Subject Code:	22SK307	L – T – P - S:	0-0-28-2 (In Hrs)	
			Credits:	1

Sl. No.	Course Objectives
1	To **develop** effective communication skills for academic, professional, and social interactions.
2	To **cultivate** assertive communication and presentation skills for impactful expression.
3	To **enhance** teamwork abilities, interpersonal relationships, and non-verbal communication.
4	To **strengthen** group discussion, motivation, leadership, and stress management skills for employability.
5	To **prepare** students for interviews, professional practices, and ethical responsibilities in workplace environments.

Module	Description	Hrs
I	**Communication Skills**: Basics, Method, Means, Process and Purpose, Basics of Business Communication, Written & Oral Communication, Listening. Communication with Confidence & Clarity- Interaction with people, the need the uses and the methods, Getting phonetically correct, using politically correct language, Debate & Extempore	6
II	**Assertive Communication-** Concept of Assertive communication, Importance and applicability of Assertive communication, Assertive Words, being	5

	assertive. **Presentation Skills** Discussing the basic concepts of presentation skills, Articulation Skills, IQ & GK, how to make effective presentations, body language & Dress code in presentation, media of presentation	
III	**Team Work**: Team Work and its important elements Clarifying the advantages and challenges of team work Understanding bargains in team building Defining behavior to sync with team work Stages of Team Building Features of successful teams. **Body Language & Proxemics**: Rapport Building - Gestures, postures, facial expression and body movements in different situations, Importance of Proxemics, Right personal space to maintain with different people.	**5**
IV	**Group discussion, Motivation and Stress Management** a. Theory & Evaluation: Understanding why and how is the group discussion conducted. b. Techniques of group discussion. c. Discussion on FAQs of group discussion d. Body language during group discussion. Self-motivation, group motivation, leadership abilities, Stress clauses and stress busters to handle stress and de-stress; Understanding stress - Concept of sound body and mind, Dealing with anxiety, tension, and relaxation techniques. Individual Counseling & Guidance, Career Orientation. Balancing Personal & Professional Life	**6**
V	**Interview Skills, Professional Practice** a. Personal and Group Interviews. b. Mock Interviews - Questions asked & how to handle them. c. Body language in interview. d. Etiquette, Dress code in interview e. Behavioral and technical interviews. f. Practice on stress interviews, technical interviews, General HR interviews **Professional Practice**: Professional Dress Code, Time Sense, Respecting People & their Space, Relevant Behavior at different Hierarchical Levels. Positive Attitude, Self Analysis and Self-Management. Professional Ethics values to be practiced, standards and codes to be adopted as professional engineers in the society for various projects. Balancing Personal & Professional Life.	**6**

Note: Mention text book referred along with sections for more clarity in each units (e.g, Text 1: 2.1,2.5,…Text2: 1.2,2.3)

Text Books:

Sl No	Text Book title	Author	Volume and Year of Edition
1	Communication Skills for Engineers	Sunita Mishra, C.Murali Krishna	Pearson, 2nd Edition, 2011
2	Business Communication	Meenakshi Raman, Prakash Singh	Oxford University Press, 2012

Reference Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	Technical Communication Principles and Practices,	Meenakshi Raman and Sangeeta Sharma,	Oxford Publishers, 2004
2	Crucial Conversations: Tools for Talking When Stakes are High	Kerry Patterson, Joseph Grenny, Ron McMillan, Crucial Conversation	McGraw-Hill Publication, ISBN: 9780071772204
3	Business Etiquette: A Guide for the Indian Professional	Shital Kakkar Mehra	HarperCollins, 2012

Course Outcomes:

Course outcome	Descriptions
CO1	Demonstrate effective oral and written communication with clarity and confidence. **(Apply)**
CO2	Apply assertive communication and presentation skills in academic and professional contexts. **(Apply)**
CO3	Exhibit teamwork, collaboration, and appropriate non-verbal communication in group settings. **(Apply/Analyze)**

CO4	Participate actively in group discussions, applying leadership, motivation, and stress management techniques. **(Analyze)**
CO5	Perform effectively in interviews and professional practices by demonstrating etiquette, ethics, and workplace readiness**. (Apply/Create)**

Course Articulation Matrix:

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1									3	3	2		
CO2									3	3	2		
CO3									3	3	2		
CO4									3	3	2		
CO5									3	3	3		

Department: COMMON TO ALL BRANCHES			Semester:	III
Subject: CONSTITUTION OF INDIA				
Subject Code:	22CI308	L – T – P - S:	14-0-0-16 (In Hrs)	
			Credits:	1

Sl. No.	Course Objectives
1	To be **familiar** with salient features and preamble of the constitution of India. Including fundamental rights of the citizen of India and types of Fundamental rights
2	To **understand** the relevance of directive principles under part-IV, and the responsibilities of the individuals towards society.
3	To **understand** the powers and functions of the Legislature, Executive, and judicial bodies.
4	To **provide** the information of FDs, Electoral Process, emergencies and amending procedures.

Module	Description	Hrs
I	Introduction, Meaning and definitions. Salient features, Sources, Constituent Assembly, Drafting Committee. Preamble to the constitution of India. **Bloom's Taxonomy Level: L_1 – Remembering, L_2 –**	**3**
II	Fundamental rights under part III – details of exercise of rights, Scopes & Limitations and, important cases **Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.**	**3**
III	Relevance of directive principles of state policy under part-IV Fundamental duties and their significance-part-IV A **Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.** **Textbooks:** Durga Das Basu – Ch. 14, 15 MV Pylee – Ch. 4	**3**

IV	Union Executive- President, Prime minister, Parliament and Supreme Court of India. State Executive – Governors, Chief Ministers, State legislature and High Courts. **Bloom's Taxonomy Level: L_1 – Remembering, L_2 –**	**3**
V	Constitutional Special Provisions for Scheduled Castes and Tribes, Women, Children and backward classes. Emergency provisions under Part XVIII. Electoral process, Amendment procedure, 42nd, 44th, 74th, 76th, and 91stConstitutional amendments. **Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.** **Textbooks:** Durga Das Basu – Ch. 21, 22, 23, 24 MV Pylee – Ch. 7	**2**

Text Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	Introduction to the Constitution of India" (student edition)	DurgaDas Basu,	EEE, 19th/20th Edn.,2001
2	An Introduction to Constitution of India	MV Pylee.	Volume-1 Vikas Publishing, 2002

Reference Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	An Introduction to Constitution of India"	Brij kishore Sharma,	prentice-Hall of India, Volume-12002
2	Constitution of India and Professional Ethics	V. Rajaram	Second Edition New Age International Publication. 2011

Course Outcomes:

Course outcome	Descriptions
CO1	Have general knowledge and legal literacy and thereby to take up competitive examinations
CO2	Understand the freedom, rights and restrictions including directives, and fundamental duties
CO3	Understand the importance of the three main organs of the constitution, Viz-the legislature, the executive and the judiciary.
CO4	Understand the power and functions of political institutions established throughout the country
CO5	To understand the constitutional special provisions, electoral procedure, and important amendments.

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2
CO1						2	1	3	3	2			
CO2						2	2	3	3	2			
CO3						2	3	3	2	2			
CO4						2	2	3	3	2			
CO5						2	2	3	3	2			

Scheme of Teaching and Examination-2022 (160 Credits Scheme, NEP)

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

IV Semester B.E.

Sl No.	Course Code		Course Title	Teaching Dept.	Teaching Hrs.					Credits	Examination			
					L	T	P	S	Total		CIE	SEE	Total Marks	Exam Hrs
01	BS	22SS401	Combinatorics and Advanced Linear Algebra	MA	42	-	-	48	90	3	50	50	100	3
02	PC	22CY402	Information theory for Cyber Security	CY	42	-	-	48	90	3	50	50	100	3
03	PC	22CY403	Computer Communication Networks	CY	42	-	28	50	120	4	50	50	100	3
04	PC	22CY404	Database Management System	CY	42	-	28	50	120	4	50	50	100	3
05	PC	22CY405	Algorithm Design and Analysis	CY	42	-	-	48	90	3	50	50	100	3
06	PC	22CY406	Dept. Skill Lab - II (Algorithm Design and Analysis Lab)	CY	14	-	28	18	60	2	50	50	100	3
07	HS	22HV407	Universal Human Values	HS	14	-	-	16	30	1	50	-	50	-
08	HS	22EN408	Environmental Studies	HS	14	-	-	16	30	1	50	-	50	-
L-Lecture, T-Tutorial, P-Practical,/Drawing, CIE-continuous Internal Evaluation, SEE-Semester End Examination, S- Self Study				**Total**	**252**	**0**	**84**	**294**	**630**	**21**	**400**	**300**	**700**	**-**
Credit Distribution: BS: Basic Science-03, PC: Professional Core-16, HS: Humanity Science-02, **Total=21 Credits.**														

Department: MATHEMATICS			Semester:	IV
Subject: Combinatorics and Advanced Linear Algebra (Common to AI&ML, CR CS, DS and IS)				
Subject Code:	22SS401	L – T – P - S:	42-0-0-48 (In Hrs)	
			Credits:	3

Sl. No.	Course Objectives
1	To **introduce** the concept of generating function, exponential generating functions.
2	**Describe** the concepts of Derangements, Rook polynomials.
3	To **solve** simultaneous algebraic equations using methods of matrix algebra.
4	To **introduce** concepts of inner products to matrix decomposition.

Module	Description	Hrs
I	**The principle of Inclusion and Exclusion:** The principle of Inclusion and Exclusion, Generalizations of Principle. Derangements, Rook Polynomials, Arrangements with forbidden positions.	08
II	**Generating functions:** Ordinary Generating functions**,** Definition and problems. Calculational Techniques, Partition of Integers, Exponential generating function, problems.	09
III	**Vector spaces**: Solution of system of equations by LU decomposition method. Vector space, Subspaces, Linear Combinations, Linear Spans, row space and column space of a Matrix, Linear Dependence and Independence (all statements only). **Basis and Dimensions:** Basis and Dimensions of Vector space and problems.	09
IV	**Linear transformation:** Introduction, Linear Mappings, Kernel and Image of a linear transformations, Matrix representation of linear transformations, Range space, Null space, Nullity, Rank-Nullity Theorem, Singular and Nonsingular linear transformations (all statements only), Problems.	08
V	**Inner Product spaces:** Inner product, norms of a vector, angle between vectors. Orthogonal vectors, orthogonal and orthonormal basis, projections of a vector. Gram-Schmidt orthogonalization	08

	process, QR-factorization (all statements only), problems. Diagonalization of a matrix (symmetric matrices) and singular value decomposition, Problems.	

Note:
Text Book 1: Module-I**: 8.1 to 8.5;** Module-II**: 9.1 to 9.4**
Text Book 2: Module-III**: 2.4,2.6;** Module-IV**:2.7;** Module-V**:3.1,3.2,3.5,3.8**

Text Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	Discrete and Combinatorial Mathematics	Ralph P. Grimaldi	5th edition, 2006, Pearson Education, ISBN-13: 978-81-7758-424-0.
2	Mathematics for Machine Learning	Marc Peter Deisennoh, A. Aldo Faisal, Cheng Soon Ong	ISBN:978-1-108-47004-9

Reference Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	Linear Algebra and its Applications	Glibert Strang	4th edition, 2006, Cengage Learning India Edition, ISBN: 81-315-0172-8.
2	Introductory Combinatorics	Richard A. Brualdi	5th Edition, 2014, Pearson Prentice Hall, ISBN:978-0136020400.

Course Outcomes:

CO1	**Understand** the concept Principle of inclusion-exclusion, Rook polynomial, generating function, vector space, linear transformations and Inner product spaces. (L1)
CO2	**Formulate** the techniques of QR and singular value decomposition for data compression, LU factorization in solving linear system of equations. (L2)
CO3	Make use of the knowledge of Rook polynomial, linear algebra to model and solve that appears in engineering sciences. (L2)
CO4	**Apply** the idea of generating functions, Linear transformations, Arrangement with forbidden positions and inner product spaces in Engineering field. (L3)
CO5	**Analyze** the concepts of Principle of inclusion-exclusion, Rook polynomial, generating function, techniques of QR and singular value decomposition for data compression, LU factorization in solving engineering problems. (L3)

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3											
CO2	3	3	2										
CO3	3	3	2								1		
CO4	3	3	2	1							1		
CO5	3	2		1							1		

Department: CSE (Cyber Security)			Semester:	IV
Subject: Information theory for cyber security				
Subject Code:	22CY402	L – T – P – C-S:	42-0-0-48 (In Hrs.)	
			Credits:	3

Sl. No.	Course Objectives
1	To **understand** information theoretic behavior of a communication system.
2	To **understand** various channel coding techniques and their capability.
3	To **understand** various source coding techniques for data compression
4	To **Build** and understanding of fundamental concepts of data communication and networking.

Module	Description	Hrs
I	**Information Theory:** Introduction, Measure of information, Average information content of symbols in long independent sequences, Average information content of symbols in long dependent sequences. Mark-off statistical model for information source, Entropy and information rate of mark-off source**.** **Textbook 1:** Ch1–2, **Textbook 2:** Ch2	**09**
II	**Source Coding:** Encoding of the source output, Shannon's encoding algorithm. Communication Channels, Discrete communication channels, Continuous channels. Fundamental Limits on Performance: Source coding theorem, Huffman coding, Discrete memory less Channels, Mutual information, Channel Capacity. **Textbook 1:** Ch3–4, **Textbook 2:** Ch3 & 5	**09**
III	**Channel coding theorem:** Differential entropy and mutual information for continuous ensembles, Channel capacity Theorem. **Textbook 1:** Ch5, **Textbook 2:** Ch6	**08**
IV	**Introduction to Error Control Coding:** Introduction, Types of errors, examples,	**08**

	Types of codes Linear Block Codes: Matrix description, Error detection and correction, Standard arrays and table look up for decoding. **Textbook 1:** Ch7, **Textbook 2:** Ch8	
V	**Binary Cycle Codes:** Algebraic structures of cyclic codes, Encoding using an (n-k) bit shift register, Syndrome calculation. BCH codes. RS codes, Golay codes, shortened cyclic codes, Burst error correcting codes. Burst and Random Error correcting codes' **Textbook 1:** Ch8-9, **Textbook 2:** Ch9	**08**

Text Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	Digital and analog communication systems	K. Sam Shanmugam	John Wiley.
2	Digital communication,	Simon Haykin	John Wiley, 2003

Reference Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	ITC and Cryptography	Ranjan Bose	TMH, II edition, 2007
2	Digital Communications	Glover and Grant	Pearson Ed. 2nd Ed 2008

Course Outcomes:

Course outcome	Descriptions
CO1	**Analyze** the principles and applications of information theory
CO2	**Apply** information theory and linear algebra in source coding and channel coding
CO3	**Understand** various error control encoding and decoding techniques
CO4	**Analyze** the performance of error control codes
CO5	**Apply** information theory concepts and coding techniques to enhance security and efficiency in modern communication systems.

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1						2					
CO2	2	3	2										
CO3	2	2	3	2									
CO4		2	3										
CO5	3	3	3	3	2								

Department: CSE (Cyber Security)	Semester:	IV

Subject: Computer Communication Networks				
Subject Code:	22CY403	L – T – P - S:	42-0-28-50 (In Hrs)	
			Credits	4

Sl. No.	Course Objectives
1	**Familiarize** the students with functions of various layers in the network model for data communications
2	**Analyze** Guided/Un-guided media, Framing techniques, flow control, error control mechanisms and Data link, MAC protocols
3	**Understand** Network layer Services, IP addressing, Packet formats & Routing protocols
4	**Comprehend** the Transport layer Services, TCP/UDP Packet formats & Protocols

Module	Description	Hrs
I	**Data Communications**: Introduction, Components, Representations, Data Flow, Networks: Network criteria, Physical Structures, Network Types: LAN, WAN, Switching, The Internet, Accessing the internet. **Network Models**: TCP/IP Protocol Suite: Layered Architecture, The OSI model: OSI versus TCP/IP. **Data-Link Layer**: Introduction, Nodes and Links, Services, Categories of link, two sub layers, Link Layer addressing: ARP, Data Link Control (DLC) services: Framing, Flow and Error Control, Simple protocol, Stop and wait protocol (Text 1: 1.1, 1.1.1, to 1.1.3, 1.2, 1.2.1, 1.2.2, 1.3, 1.3, 1.3.1, to 1.3.5 , 2.2, 2.2.1, to 2.2.3, 2.3, 2.3.1, 9.1, 9.1.1, 9.1.2, 9.1.4, 9.2, 9.2.2, 11.1, 11.1.1, 11.1.2, 11.2.1, 11.2.2) Textbook 1: Ch. 1, 2, 9, 11 → OSI, TCP/IP, Data Link Basics	08
II	**Media Access Control**: Introduction. Random Access: ALOHA, CSMA, CSMA/CD, CSMA/CA. Controlled Access: Reservation, Polling, Token Passing. Channelization: FDMA, TDMA, CDMA. **Physical Layer:** Introduction to Guided and unguided physical	08

	media. **Wired and Wireless LANs:** IEEE project 802, Ethernet Evolution, Standard Ethernet: Characteristics, Efficiency, and Implementation. **Wireless LANs**: Characteristics, Access control, IEEE 802.11 project: Architecture, , MAC Sub layer, Bluetooth: Architecture. (Text 1: 12.1, to 12.1.4, 12.2.1, to 12.2.3, 12.3, 12.3.1, to 12.3.3, 7.2, 7.2.1, to 7.2.3, 7.3, 7.3.1, to 7.3.3, 13.1.1, 13.1.2, 13.2, 13.2.1, 13.2.4, 13.2.5, 15.1.2, 15.1.3, 15.2, 15.2.1, 15.2.2, 15.3, 15.3.1) Textbook 1: Forouzan Ch. 7, 12, 13, 15 → MAC, Channelization, Wired/Wireless LANs	
III	**Connecting Devices:** Introduction, Hubs, link layer Switches, Routers, Virtual LANs: Membership, Configuration **Network Layer:** Introduction, Network Layer services: Packetizing, Routing and Forwarding. **IPV4Addresses:** Address Space, Classful Addressing, Classless Addressing, Network Address Translation. (Text 1: 17.1.1, 17.1.2, 17.1.3, 17.2, 18.1, 18.1.1, 18.1.2, 18.4, 18.4.1, to 18.4.3, 18.4.5) Textbook 1: Ch. 17, 18 → Connecting Devices, IPv4 Addressing	**09**
IV	**Network Layer Protocols:** Introduction, Internet Protocol (IP): Datagram Format, Security of IPv4 Datagram, Mobile IP: Addressing, Agents, Three Phases, Inefficiency in Mobile IP. **Next Generation IP:** IPV6 Addressing, Representation, Address Space, IPV6 Protocol- packet format, Transition from IPv4 To IPv6, Strategies. **Uni-cast Routing:** Routing Algorithms: Distance Vector Routing, Link State Routing. (Text 1:19.1, 19.1.1, 19.1.4, 19.3, 19.3.1, to 19.3.4, 22.1, 22.1.1, 22.1.2, 22.2, 22.2.1, 22.4, 22.4.1, 20.2, 20.2.1, 20.2.2) Textbook 1: Ch. 19, 20, 22 → IPv4, IPv6, Routing Algorithms	**08**
V	**Transport Layer:** Transport Layer Services, Protocols, Transport Layer Protocols: Stop & wait protocol, Go-Back-N Protocol, Selective Repeat protocol. **Transport Layer Protocols in the Internet:** User Datagram Protocol: User Datagram, UDP Services, UDP Applications, Transmission Control Protocol: TCP Services, TCP Features, TCP Segment, TCP Connection. (Text 1: 23.1.1, 23.2, 23.2.2, 23.2.3, 23.2.4, 24.2, 24.2.1, to 24.2.3, 24.3, 24.3.1, to 24.3.4) Textbook 1: Ch. 23, 24 → Transport Layer, UDP, TCP	**09**

LAB CONTENT:

Sl. No.	Experiment Description
	PART-A: Experiments using C/Python programming
01	Implement Bit stuffing & De-stuffing Algorithm
02	Implement Character stuffing & De-stuffing Algorithm
03	Implement Encryption and Decryption algorithms
04	Implement STOP and WAIT protocol, Sliding window protocol.
	PART-B: Simulation Experiments using Cisco Packet tracer/NS2/NS3
01	Simulate a four-node point to point network with duplex links between them and set the queue size to vary bandwidth and to find the number of packets dropped.
02	Simulate different types of internet traffic such as FTP and TELNET over a network to analyze the throughput.
03	Simulate Ethernet LAN using n nodes and set multiple traffic nodes to determine collision across different node.
04	Test and verify Network configurations using Packet Tracer.
05	Performing an Initial Router configuration Cisco Packet Tracer.
06	Performing OSPF configuration using Cisco Packet Tracer.

Text Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	Data Communication and Networking	B Forouzan	McGraw Hill,2013, 5th Edition
2	Computer networks	Andrew Tenenbaum	Pearson Prentice hall, 2010, 4th Edition

Reference Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	Computer Networks	James F.Kurose, Keith W.Ross	Pearson Edu., 2ndEdition, 2003
2	Introduction to Data Communication and Networking	Wayne Tomasi	Pearson Edu., 2007
3	Computer Networks	V.S. BagadandI. A .Dotre	Technical publications, 2ndedition, 2009.

Course Outcomes:

Course outcome	Descriptions
CO1	**Identify** the functions of various layers in the network model (OSI, TCP/IP) for data communications. (L1)
CO2	**Demonstrate** Guided/Un-guided media, Framing techniques, flow control, error control mechanisms and Data link, MAC protocols. (L3)
CO3	**Summarize** & Simulate Network layer devices, Services, IP Packet formats, Protocols. (L2)
CO4	**Interpret** Transport layer Services, Packet formats, Protocols(L3)
CO5	**Apply** networking concepts, protocols, and simulation tools to design, analyze, and troubleshoot computer communication networks

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													3
CO2	2	2	2	1	2					1			2	2
CO3	2	2	1		2					1			2	2
CO4	2	2	1		2					1				2
CO5	3	3	3	3	3									

Department: CSE (Cyber Security)	**Semester:**	**IV**

Subject: Database Management System				
Subject Code:	**22CY404**	**L – T – P – C:**	**42-0-28-50 (In Hrs)**	
			Credits	**4**

Sl. No.	**Course Objectives**
1	**Provides** a strong foundation in Database concepts, technology, and practice
2	**Practice** SQL programming through a variety of database problems.
3	**Demonstrate** use of concurrency and transactions in the database.
4	**Design** and build database applications for real-world problems.

Module	**Description**	**Hrs**
I	**Introduction to Database Systems** -Databases and Database users: Introduction, An example, Characteristics of Database Approach, Advantages of using the DBMS approach, Data Models, Schemas and Instances, Degrees of data abstraction and Data Independence, Three-schema Architecture, The Database System Environment. **Data Modeling Using the Entity-Relationship Model-** High-Level Conceptual Data Models for Database Design; Entity Types, Entity Sets, Attributes and Keys; Relationship types, Relationship Sets, Roles and Structural Constraints; Weak Entity Types, Specialization and Generalization. **Textbook 1: Ch 1,2, 3, 4** **Textbook 2: Ch 1,2**	**08**
II	**Relational Model** - Relational Model Concepts, Relational Model Constraints, and Relational database schemas, Update operations, transactions, and dealing with constraint violations. **Relational Algebra** -Unary and Binary Relational Operations: SELECT and PROJECT; Relational Algebra Operations from Set Theory; Additional relational operations (aggregate, grouping, etc.), Examples of Queries in Relational Algebra. Binary Relational Operations: JOIN and DIVISION; Examples of Queries	**08**

	in Relational Algebra. **Mapping Conceptual design into Logical design-** ER Diagrams, Constraints, Codd's rules, and Relational Database design using ER-to-Relational Mapping. **Textbook 1: Ch 5,6.9** **Textbook 2: Ch 2,3,4**	
III	**SQL-** SQL data definition and data types, specifying constraints in SQL, retrieval queries in SQL, INSERT, DELETE, and UPDATE statements in SQL, Additional features of SQL.**Constraints** - What are constraints, Different types of constraints **Views-** Introduction to views, data independence, security, updates on views, comparison between tables and views. **Application Development-** Accessing databases from applications, An introduction to JDBC, JDBC classes and interfaces, SQLJ, and Stored procedures. **Textbook 1: Ch 6,7,8,9** **Textbook 2: Ch 5,6**	**09**
IV	**Normalization-** Introduction to Normalization, Functional and Multivalued Dependencies, Design guidelines for relation schema, Functional Dependencies, First Normal Form, Second and Third Normal Forms, Boyce- Codd Normal Form, Multivalued Dependency and Fourth Normal Form, Join Dependencies and Fifth Normal Form. Examples of normal forms. **Textbook 1: Ch 14,15,20** **Textbook 2: Ch 7**	**09**
V	**Transaction management** -Introduction to Transaction Processing, Transaction and System concepts, Serializability and concurrency control characterizing schedules based on recoverability, and Transaction support in SQL. **Concurrency Control in Databases-** Lock based concurrency control (2PL, Deadlocks), Timestamp ordering, optimistic methods, Multiple version Concurrency control technique, database recovery management. **Textbook 1: Ch 20,21,22** **Textbook 2: Ch 18,19**	**08**

LAB CONTENT:

Sl. No.	Experiment Description
1	Consider the following schema for Insurance database: PERSON (driver_id , name, address) CAR (regno, model, year) ACCIDENT (reportno, accd_date, location) OWNS (driver_id, regno) PARTICIPATED (driver_id, regno, reportno, damage_amt)
2	Consider the following database schema for student database: STUDENT (usn, name, major, bdate) COURSE (courseno, cname, dept) TEXT (book_ISBN, book_title, publisher, author) ENROLL (usn,courseno, sem,marks) BOOK _ ADOPTION (courseno, sem, book_ISBN)
3	Consider the schema for Company Database: DEPARTMENT (DNo, DName, MgrSSN, MgrStartDate) EMPLOYEE (SSN, Name, Address, Sex, Salary, SuperSSN, DNo) DLOCATION (DNo,DLoc) PROJECT (PNo, PName, PLocation, DNo) WORKS_ON (SSN,PNo, Hours)
4	Consider the following schema for Movie Database: ACTOR (Act_id, Act_Name, Act_Gender) DIRECTOR (Dir_id, Dir_Name, Dir_Phone) MOVIES (Mov_id, Mov_Title, Mov_Year, Mov_Lang, Dir_id) MOVIE_CAST (Act_id,Mov_id, Role) • RATING (Mov_id, Rev_Stars
5	Mini-Project: A Mini Project should be implemented and shall be carried out in a batch of two students. The students will finalize a topic in consultation with the faculty. The mini project must be carried out in the college only.

	The Mini Project tasks would involve: a. Understand the complete domain knowledge of application and derive the complete data requirement specification of the Mini Project b. Design of the project c. Normalization of the Relational design. d. Documentation and submission of report. Typical Mini Projects: a. Placement management system. b. Result management & analysis system. c. SSIT Blog management system. d. Student Feedback system. e. Library management. f. Electricity Bill Management System. g. Online Retail Application Database. h. Inventory Control Management. i. Library Management System. j. Student Database Management. k. Payroll Management System. l. Voice-based Transport Enquiry System. m. SMS-based Remote Server Monitoring System. n. Restaurant Management. o. Pharmacy Management System. p. Hospital Management System. q. Centralized College Database. r.Art Gallery Management Database

Text Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	Fundamentals of Database Systems	Ramez Elmasri and Shamkant B. Navathe	7th Edition, Pearson Education 2017 ISBN 978-9332582705
2	Database management systems	Ramakrishnan, and Gehrke	3rd Edition, McGraw Hill 2014.

Reference Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	Database System Concepts 6th Edition	Abraham Silberschatz, Henry F. Korth and S. Sudarshan's	ISBN 978-9332901384 2013

Course Outcomes:

Course outcome	Descriptions
CO1	**Identify**, analyse, and define database objects, enforce integrity constraints on a database using RDBMS
CO2	**Use** SQL for database manipulation and demonstrate the basics of query evaluation.
CO3	**Design** and build simple database systems
CO4	**Develop** applications to interact with databases and relational algebra expression.
CO5	**Apply** database design, normalization, SQL, and transaction management concepts.

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	3	3							1			
CO2	3	3	3	2	3						2		
CO3	3	3	3	3	2		3	2					

CO4	2	3		2			3						
CO5	3	3	3	3	2	3							

Department: CSE (Cyber Security)			Semester:	IV
Subject: Algorithm Design and Analysis				
Subject Code:	22CY405	L – T – P - S:	42-0-0-48 (In Hrs)	
			Credits:	3

Sl. No.	Course Objectives
1	**Understand** basic efficiency classes and asymptotic notations to express the complexity of algorithms.
2	**Know** the different Algorithm Design Techniques for effective problem solving.
3	**Analyze** the algorithm with respect to space and time complexity.
4	**Comparison** of algorithm efficiency in different design techniques.

Module	Description	Hrs
I	**Introduction, Fundamentals of the Analysis of Algorithm Efficiency, Brute Force**: Algorithm Definition, Fundamentals of algorithmic problem solving, Analysis Framework, Formal Definitions of Asymptotic Notations, Basic efficiency classes, Mathematical analysis of non-recursive and recursive Algorithms with Examples. **Brute Force**: String Matching. **Textbook 1: Chapter: 1 1.1, 1.2, 2.1-2.4, 3.2**	**08**
II	**Divide and Conquer:** Merge Sort, Quick Sort, Finding the Maximum and Minimum. **Decrease and Conquer**: Insertion Sort, Topological Sorting. **Textbook 1: Chapter: 5 5.1, 5.2,4.1, 4.2**	**08**
III	**Transform and Conquer:** Heaps and Heap Sort and AVL Trees. **Space and Time Tradeoffs:** Input Enhancement in String Matching- Horspool‟s algorithm, Hashing: Hash table, Hash functions, Collision handling by open addressing and chaining. **Textbook 1: Chapter: 6.3, 6.4, 7.2, 7.3**	**08**

IV	**Greedy Technique:** Prim"s algorithm, Kruskal"s algorithm, Dijkstra"s algorithm. **Dynamic Programming:** Floyd"s Algorithms, Knapsack Problem and Memory Functions. **Textbook 1: Chapter: 8.2, 8.4, 9.1- 9.3**	**09**
V	**Back tracking:** n-Queen"s Problem, Subset-Sum Problem. **Branch and Bound:** Assignment Problem, Knapsack Problem, and Traveling Salesman Problem. **Textbook 1: Chapter: 12.1, 12.2**	**09**

Text Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	Introduction to the Design & Analysis of Algorithms	Anany Levitin	3rd Edition, ISBN-13: 978-0-13-231681-1
2	Computer Algorithms/C++	Ellis Horowitz, SatrajSahni and Rajasekaran	2nd Edition, ISBN-13: 978-8173716119

Reference Books:

Sl. No	Text Book title	Author	Volume and Year of Edition
1	Introduction to Algorithms	Cormen T.H, Leiserson C.E.&Rivest R.L	3rd Edition ISBN- 13: 978-0262033848 -2012
2	Algorithm Design Pearson	Jon Kleinberg andEva Tardos	1st Edition 2013
3	Design and Analysis of Algorithms	S. Sridhar	Oxford university press, 2014

Course Outcomes:

Course outcome	Descriptions
CO1	Understand the basic concepts of algorithm analysis.
CO2	Demonstrate various algorithm design techniques.
CO3	Design an algorithm and analyze its complexity to rank order of growth.
CO4	Apply the appropriate algorithm design technique to solve the given problem instance.
CO5	Evaluate and compare multiple algorithms for efficiency, scalability, and suitability, providing optimal solutions for real-world computational problems

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	3	2	3								
CO2	3	3	3	3	2								
CO3	2	3	3	3	3								
CO4		3	3	3	3								
CO5	3	3	3	3	3								

Department: CSE (Cyber Security)	Semester:	IV

Subject: Algorithm Design and Analysis Lab				
Subject	22CY406		L-T-P-S	14 – 0 –28 –18
			Credit	2

Sl. No.	Course Objectives
1	**Understand** basic efficiency classes and asymptotic notations to express the complexity of algorithms.
2	**Know** the different Algorithm Design Techniques for effective problem solving.
3	**Analyze** the algorithm with respect to space and time complexity
4	**Comparison** of algorithm efficiency in different design techniques

LAB CONTENT:

Sl. No.	Experiment Description
1	**Brute Force**: String matching.
2	**Divide and Conquer:** • Sort a given set of elements using Merge sort. • Sort a given set of elements using Quick Sort. • Finding the Maximum and Minimum element in an array of „n‟ integers.
3	**Decrease and Conquer:** • Print the vertices of the directed acyclic graph in topological order using Source Removal Method. Sort a given set of elements using Insertion Sort.
4	**Transform and Conquer:** Create a heap tree for a given list of N elements using Bottom-up approach and sort the elements using Heap Sort Technique.
5	**Space and Time Tradeoffs:** Implement Horspool algorithm for String Matching..
6	**Greedy Technique:** • Find Minimum Cost Spanning Tree of a given undirected graph using Prim‟s algorithm. • Find Minimum Cost Spanning Tree of a given undirected graph using Kruskal‟s algorithm. From a given vertex in a weighted connected graph, find the shortest paths to other vertices using Dijkstra's algorithm.
7	**Dynamic Programming:**

	• Solve Knapsack problem and print the solution vector. Find all pair shortest path using Floyd"s Algorithm..
8	**Back Tracking:** Implement N Queen's algorithm.Find a subset of a given set S of N positive integers whose sum is equal to a given positive integer D.

Course Outcomes:

Course outcome	Descriptions
CO1	**Understand** the basic concepts of algorithm analysis.
CO2	**Demonstrate** various algorithm design techniques.
CO3	**Design** an algorithm and analyze its complexity to rank order of growth.
CO4	**Apply** the appropriate algorithm design technique to solve the given problem instance.
CO5	**Evaluate** and compare the performance of different algorithm implementations through experimental analysis and case studies.

Course Articulation Matrix:

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2										
CO2	1	3	3	2									
CO3		2	2	2									
CO4	2	3	3	2									
CO5	3	3	3	3	2								

Department: Common to all branches			Semester:	IV
Subject: Universal Human Values-II (UHV-II)				
Subject Code:	22HV407	L – T – P - S:	14-0-0-16 (In Hrs)	
			Credits:	1

Sl. No.	Course Objectives
1	This introductory course input is intended: To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity
2	To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of
3	To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.
4	This course is intended to provide a much-needed orientation input in value education to the young enquiring minds.

Module	Description	Hrs
I	**Introduction to Value Education:** -Understanding Value education. -Self-exploration as the process for Value Education. -The Basic Human Aspirations and their fulfillment. -Right Understanding, Relationship and Physical Facility. -Happiness and Prosperity-Current Scenario. -Method to Fulfill the Basic Human Aspirations. **Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.**	**3**

II	**Harmony in the Human Being:** -Understanding the Human being as the Co-existence of the Self and Body. -Distinguishing between the Needs of the Self and the Body. -The Body as an Instrument of the Self. -The response of the self and the body. -Understanding Harmony in the Self.	**3**
III	**Harmony in the Family and Society:** -Understanding Harmony in the Family – The Basic Unit of Human Interaction -'Trust' – the Foundational Value in Relationship. - 'Respect' – as the Right Evaluation. -Other Values in Human –to- Human Relationship -Understanding Harmony in the society. -Vision for the Universal Human Order. **Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.**	**3**
IV	**Harmony in the Nature(Existence):** -Understanding Harmony in the Nature. -Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature. Realizing Existence as Co-existence at All Levels. -The Holistic Perception of Harmony in Existence. **Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.**	**2**
V	**Implications of the Holistic Understanding – a Look at Professional Ethics:** -Basis for universal Human Values. -Definitiveness of (Ethical) Human Conduct. -Professional Ethics in the light of Right Understanding. -A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order. -Holistic Technologies, Production Systems and Management	**3**

Text Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	A Foundation Course in Human Values and	R R Gaur, R Sangal	Excel Books, New Delhi,2010
2	The Teacher's Manual Teachers' Manual for A Foundation Course in Human Values and Professional Ethics	R R Gaur, R Asthana, G P Bagaria	2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

Reference Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	Jeevan Vidya: EkParichaya,.	A Nagaraj,	Jeevan Vidya Prakashan, Amarkantak, 1999.
2	Human Values,	A.N. Tripathi,	New Age Intl. Publishers, New Delhi, 2004
3	The Story of Stuff (Book).. i)Small is Beautiful ii)Slow is Beautiful	- E. F Schumacher. - Cecile Andrews	

Course Outcomes:

Course outcome	Descriptions
CO1	By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
CO2	They would have better critical ability, also become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
CO3	It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

CO4	This is only an introductory foundational input. It would be desirable to follow it up by a) Faculty-student or mentor-mentee programs throughout their time with the institution & Higher-level courses on human values in every aspect of living
CO5	Leads to form strategies for transition towards Value-based life and profession.

Course Articulation Matrix:

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1						3	3	3	2	3			
CO2				2		3	3	3	2	3			
CO3				2		3	3	3	2	3			
CO4				2		3	3	3	2	3			
CO5				2		3	3	3	2	3			

Department: Common to all branches			Semester:	IV
Subject: ENVIRONMENTAL STUDIES				
Subject Code:	22EN408	L – T – P - S:	14-0-0-16 (In Hrs)	
			Credits:	1

Sl. No.	Course Objectives
1	To identify the major challenges in environmental issues and evaluate possible solutions.
2	Develop analytical skills, critical thinking and demonstrate socio-economic skills for sustainable development.
3	To gain knowledge on different types of pollution in the environment.
4	To analyze an overall impact of specific issues and develop environmental management plan. Environment.

COURSE TOPICS:

Module	Description	Hrs
I	Introduction: Environment - Components of Environment Ecosystem: Types of Ecosystem, Balanced ecosystem. Human Activities – Food, Shelter, And Economic & Social Security, Effects of human activities on environment-Agriculture, Housing, Industry, Mining & Transportation.	3
II	Natural Resources-Introduction, types of resources, Water resources – Availability & Quality aspects, Water borne diseases & water induced diseases, Fluoride problem in drinking water. Mineral resources, Forest	3
III	Energy – Different types of energy, Conventional sources & Non-conventional sources of energy Solar energy, Hydro electric energy, Wind Energy, Nuclear energy, Biomass & Biogas Fossil Fuels, Hydrogen as an alternative energy.	3
IV	Environmental Pollution – Air Pollution & Automobile Pollution Water Pollution, Noise pollution, Land Pollution, Public Health Aspects. Global Environmental Issues: Population Growth, Urbanization, Land Management, Water & Waste Water	3

V	Definition, Effects – Global Warming, Acid rain & Ozone layer depletion, controlling measures. Solid Waste Management, E - Waste Management & Biomedical Waste Management -Sources, Characteristics & Disposal methods. Environmental Acts & Regulations, Role of government, Legal aspects, Role of Non-governmental Organizations (NGOs) , Environmental Education. **Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.**	**2**

Text Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	Environmental Studies	Benny Joseph	Tata McGraw– Hill Publishing Company Limited(2005), Delhi.
2	Environmental Studies	R Rajagopalan	From Crisis to Cure", Oxford University Press, 2005

Reference Books:

Sl. No.	Text Book title	Author	Volume and Year of Edition
1	Environmental Science and Engineering	Aloka Debi,	Universities Press (India) Pvt. Ltd. 2012
2	Environmental Studies	R.J.Ranjit Daniels and Jagadish Krishnaswamy,	Wiley India Private Ltd., New Delhi(2009),
3	Text Book of Environmental and Ecology"	Dr.Pratiba Sing, Dr.AnoopSingh and Dr.Piyush Malaviya,	Acme Learning Pvt. Ltd. New Delhi

Course Outcomes:

Course outcome	Descriptions
CO1	Understand the principles of ecology and environmental issues that apply to air, land, and water issues on a global scale

CO2	Develop critical thinking and/or observation skills, and apply them to the analysis of a problem or question related to the environment
CO3	Demonstrate ecology knowledge of a complex relationship between biotic and abiotic components
CO4	Apply their ecological knowledge to illustrate and graph a problem and describe the realities that managers face when dealing with complex issues
CO5	Understand the major environmental issues and legal regulations.

Course Articulation Matrix:

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1					2		3	3	3	1		
CO2	1					2		3	3	3	1		
CO3	1					2		3	3	3	1		
CO4	1					2		3	3	3	1		
CO5	1					2		3	3	3	1		