Syllabus

Bachelor of Technology in Defence Technology (AI & Cyber Security)
AY
(2025 onwards)

School of Defence Technology
GALGOTIAS UNIVERSITY,
Greater Noida, Gautam Buddh Nagar, Uttar Pradesh, India

Bachelor of Technology in Defence Technology (AI & Cyber Security)

Course Description:
This course provides an in-depth understanding of cyber security principles, challenges, and solutions pertinent to defence applications. It covers the threat landscape, defensive strategies, cryptography, cyber warfare, and legal aspects related to cyber security in the defence sector.

Program Introduction

1. A multidisciplinary aerospace program integrating core areas such as aerodynamics, structural design, and control systems.
2. Specializations available in Aerospace Technology or Communication Systems and Sensors.
3. Specifically tailored to meet the evolving needs of defence technology.
4. Curriculum meticulously developed in collaboration with DRDO to ensure industry relevance and excellence.

Unique features of the program

1. Courses are tailored to address challenges in defense systems, including missile technology, aerospace, electronics and communication, cybersecurity, robotics, and weapon systems.
2. Emphasizes research, innovation, and practical projects aligned with national defense priorities, encouraging students to contribute to cutting-edge defense solutions.
3. Industry and Defence Establishment Collaborations: Strong partnerships with defense agencies, research laboratories (like DRDO, ISRO), and defense industries facilitate internships, live projects, and exposure to real-world defense applications.
4. Access to advanced laboratories, simulation centers, and testing facilities specific to defense technology development.
5. Instruction by faculty with expertise in defense research, along with mentorship from defense scientists and industry professionals.
6. Training students to handle sensitive information responsibly, adhering to security clearances and confidentiality norms essential in defense projects.
7. Direct pathways to employment in defense research organizations, defense manufacturing units, and allied sectors, often with preferential recruitment and internships.
8. Integration of multiple engineering disciplines such as electronics, mechanical, aerospace, and computer science to address complex defense challenges holistically.
9. Focus on National Security and Strategic Technologies

Aim
This integrated program aims to produce highly skilled engineers with a comprehensive understanding of both fundamental and advanced defence technologies, ready to contribute to national security and technological advancements.

Program Duration
Total Duration: 4 years (8 semesters) Total **Credits:** For B.Tech course 162 credits
Degrees Awarded: **Bachelor of Technology in Defence Technology (AI & Cyber Security)**
(upon completion of 4 years),

Program Objectives

Knowledge Development: To equip students with a comprehensive understanding of core concepts in cyber security, including cryptography, network security, ethical hacking, and cyber threat analysis, tailored to defence applications.

Practical Skills: To develop students' practical skills in designing, implementing, and managing secure communication systems and cyber infrastructure critical to national defence.

Research and Innovation: To foster a research-oriented mindset that encourages innovation in developing advanced cyber defence techniques, intrusion detection systems, and secure military communication protocols.

Threat Intelligence and Analysis: To enable students to analyze emerging cyber threats, understand adversarial tactics, and develop effective countermeasures specific to defence scenarios.

Policy and Ethical Understanding: To instill awareness of cyber security policies, legal frameworks, and ethical considerations relevant to defence technology and national security.

Industry Readiness: To prepare students for careers in national security agencies, defence technology firms, and cyber security consultancies by providing industry-relevant training and certification opportunities.

Program Outcomes

Technical Expertise: Graduates will be able to demonstrate proficiency in designing, implementing, and managing secure communication systems and cyber infrastructure tailored for defence applications.

Analytical Skills: Graduates will possess the ability to analyze complex cyber threats, identify vulnerabilities, and develop effective countermeasures to protect national security assets.

Research and Innovation: Graduates will be capable of contributing to research, development, and innovation in advanced cyber security techniques, tools, and protocols relevant to defence technology.

Ethical and Legal Awareness: Graduates will understand the ethical, legal, and policy frameworks governing cyber security and defence operations, ensuring responsible and compliant practices.

Scheme of Program
Bachelor of Technology in Defence Technology (AI & Cyber Security)

Semester	Course Code	Course Name	Credit Hours (L+T+P)	Credit per week
I(Odd)	XXXX	Calculus and Linear Algebra	3+0+1	4
	XXXX	Basic Electrical Electronics Engineering	3+0+1	4
	XXXX	Programming for problem solving	2+1+1	4
	XXXX	Engineering Design and prototype	3+0+1	4
	XXXX	Big Data Engineering	3+0+0	3
	XXXX	Aptitude Skill	0+0+2	2
	XXXX	Yoga	0+0+2	NC
		Total		21
II(Even)	XXXX	Discrete Mathematics	3+0+0	3
	XXXX	Statistical Method	3+0+1	4
	XXXX	Introduction of quantum computing	2+0+1	3
	XXXX	Semiconductor and Optoelectronics Devices	3+0+1	4
	XXXX	OOPS using Python	3+0+2	5
	XXXX	Applied Aptitude Skills	0+0+2	2
	XXXX	Environmental Impact Analysis	0+0+2	NC
		Total		21
III(Odd)	**XXXX**	**Operating Systems**	**3+0+0**	**3**
	XXXX	**Data Structures and Database Management Systems**	**3+0+0**	**3**
	XXXX	**Computer Architecture and Computer Networks**	**3+0+1**	**4**
	XXXX	**Quantum mechanics**	**2+0+0**	**2**
	XXXX	**AI and Cognitive Systems**	**2+0+0**	**2**
	XXXX	**IT Workshop**	**0+0+2**	**1**
	XXXX	**Deep learning and neural network**	**4+0+0**	**4**
	XXXX	**Advanced Aptitude Skill**	**0+0+2**	**2**
		Total		21
IV(Even)	XXXX	Software Engineering	3+1+0	4
	XXXX	Algorithm analysis and design/ Web Technology and Database	3+0+2	5
	XXXX	Introduction to Cybersecurity	2+0+0	2
	XXXX	Cryptography Fundamentals	3+0+0	3
	XXXX	System Security & Risk Management	3+0+0	3
	XXXX	Linux Administration	3+0+1	4
	XXXX	Aptitude Proficiency	0+0+2	2
		Total		21
V(Odd)	XXXX	Network Security & Défense	3+0+1	4
	XXXX	Ethical Hacking & Penetration Testing	3+0+1	4
	XXXX	AR/VR, Computer Vision & Robotics	3+0+1	4

	XXXX	Cloud Security and Computing	3+0+1+1	5
	XXXX	Blockchain Security	4+0+0	4
	XXXX	Soft Skills and Aptitude Readiness	0+0+2	2
	XXXX	AI and Machine Learning	0+0+2	1
				24
VI(Even)	XXXX	Mobile Security & Application Security	3+0+1	4
	XXXX	Dron Technology and security	3+1+0	4
	XXXX	Digital Forensics	3+0+1	4
	XXXX	Data Privacy & Protection	3+0+0	3
	XXXX	Cybersecurity using AI and ML	3+0+1	4
	XXXX	Post Quantum Cryptography	4+0+0	4
		Total		23
VII(Odd)	XXXX	AI in Security/Zero Trust Architecture	3+1+0	4
	XXXX	Capstone Design Phase-I	5	5
	XXXX	Cyber Threat Intelligence	2+0+0	2
		Secure Software Development	2+0+0	2
	XXXX	Industrial Internship	1	1
	XXXX	Deep Learning and neural network	4+0+1	5
		Total		19
VIII(Even)	XXXX	Capstone Design Phase-II	10	10
	XXXX	Internship	2	2
		Total		12
		Total Credits		162

SEMESTER –I

XXXX **Calculus and Linear Algebra** **Credit: 3+0+0**

SCHEME

The scheme is an overview of work-integrated learning opportunities and gets students out into the real world. This will give what a course entails.

<table>
<tr><td>Course Title</td><td colspan="3">Calculus and Linear Algebra</td><td colspan="3">Course Type</td><td colspan="3">Integrated</td></tr>
<tr><td>Course Code</td><td colspan="3">XXXX</td><td colspan="3">Class</td><td colspan="3">B. Tech</td></tr>
<tr><td rowspan="7">Instruction delivery</td><td>Activity</td><td>Credits</td><td>Credit Hours</td><td colspan="4" rowspan="2">Total Number of Classes per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Lecture</td><td>3</td><td>3</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td rowspan="3">Theory</td><td rowspan="3">Tutorial</td><td rowspan="3">Practical</td><td rowspan="3">Self-study</td><td rowspan="3">CIE</td><td rowspan="3">SEE</td></tr>
<tr><td>Practical</td><td>1</td><td>2</td></tr>
<tr><td>Self-study</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">Total</td><td rowspan="2">4</td><td rowspan="2">5</td></tr>
<tr><td>45</td><td>0</td><td>15</td><td>0</td><td>50%</td><td>50%</td></tr>
<tr><td>Course Lead</td><td colspan="2"></td><td>Course Coordinator</td><td colspan="6"></td></tr>
<tr><td rowspan="2">Names Course Instructors</td><td colspan="3">Theory</td><td colspan="6">Practical</td></tr>
<tr><td colspan="3"></td><td colspan="6"></td></tr>
</table>

COURSE OVERVIEW: This course is familiarizing the prospective engineers with techniques in Mathematics. It aims to equip the students with standard concepts and tools at an intermediate to advance level that will serve them well towards tackling more advanced level of Mathematics and application that they would find useful in their discipline.

COURSE OBJECTIVE:

The students will be able:

1. To visualize and conceptualize the engineering problems.
2. To model the engineering problem mathematically using theory of calculus and matrices.
3. To determine the solution of the studied engineering problems from application point of view.
4. To validate the solution.
5. To implement the solution for engineering problem

COURSE OUTCOMES (COs)

After the completion of the course, the student will be able to:

CO No.	**Course Outcomes**
CO1	Summarize the fundamental concepts of single-variable calculus, matrices, sequences, series, and vector spaces.
CO2	Explain systems of linear equations, diagonalization, convergence tests for sequences and series, eigenvalues, eigenvectors, and the rank–nullity theorem

CO3	Apply techniques to evaluate definite and improper integrals, Beta and Gamma functions, solve systems of linear equations, compute eigenvalues/eigenvectors, diagonalize matrices, and expand functions into Fourier series.
CO4	Analyze convergence of sequence and series, structure of vector spaces, orthogonality / orthonormality, and relationships between linear maps and their associated matrices.

BLOOM'S LEVEL OF THE COURSE OUTCOMES

Bloom's taxonomy is a set of hierarchical models used for the classification of educational learning objectives into levels of complexity and specificity. The learning domains are cognitive, affective, and psychomotor.

CO No.	Remember **BTL1**	Understand **BTL2**	Apply **BTL3**	Analyse **BTL4**	Evaluate **BTL2**	Create **BTL6**
1	✓					
2		✓				
3			✓			
4				✓		

PROGRAM OUTCOMES (POs): AS DEFINED BY CONCERNED THE APEX BODIES

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues, and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics, responsibilities, and norms of the engineering practice.
PO9	**Individual and Teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities

	with the engineering community and with society, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. COURSE

PSO1: Ability to work with emerging technologies in computing requisite to Industry 4.0
PSO2: Demonstrate Engineering Practice learned through industry internship to solve live problems in various domains.

COURSE ASSESSMENT

Assessment pattern for Blended/ Integrated course

Type of Course	**CIE Weightage**			**End Term Exam (ETE) Weightage**
	LAB (Daily Work/ Record)	**LAB EXAM**	**Mid Term Exam**	
Integrated (B)	**25**	**25**	50	50
Final Weightage	**25**		25	50
Total	100			

CONTENTS:

UNIT 1: Rolle's Theorem, Mean value theorems, indeterminate forms and L'Hospital's rule, Evaluation of definite and improper integrals; Beta and Gamma functions and their properties.

UNIT 2: Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions, Fourier series, Half range Fourier sine and Half range Fourier cosine series.

UNIT 3: Basic Operations on matrices and vectors, Determinants, Inverse of matrix using Gauss Jordan elimination, Rank of a matrix, Solution of system of linear equations: Gauss elimination. Eigen values, eigenvectors, Similarity and Diagonalization.

UNIT 4: Vector Space, Linear Independence of vectors, basis, dimension; Linear transformations (maps), range and kernel of a linear map, rank, nullity, rank-nullity theorem, Inverse of a linear transformation, composition of linear maps, Matrix associated with a linear map. Inner product spaces, Norms, Orthogonally, Orthogonal and Orthonormal Basis, Orthogonal Projections, Gram-Schmidt orthogonalization.

BIBLIOGRAPHY

Text Books:

1. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
2. *Erwin Kreyszig*, Advanced Engineering Mathematics, 10^{th} Edition, John Wiley & Sons.
3. *Peter V. O'Neil,* Advanced Engineering Mathematics, 7^{th}Edition,Cengage Learning.

4. *Robert T. Smith and Roland B. Minton,* Calculus, 4th Edition, McGraw Hill Education.
5. *George B. Thomas and Ross L. Finney*, Calculus, 9th Edition, Pearson Education.

Reference Books:

1. *R. K. Jain and S. R. K. Iyengar,* Advanced Engineering Mathematics, 4th Edition, Narosa Publishers.
2. *Robert T. Smith and Roland B. Minton,* Calculus, 4th Edition, McGraw Hill Education.
3. *David C Lay,* Linear Algebra and its application, 3rd Edition, Pearson Education.
4. *Michael D. Greenberg*, Advanced Engineering Mathematics, 2nd Edition, Pearson Education.

Practical

Objective: The objective of this course is to enhance the problem-solving skills of prospective engineers using open-source software/ computer algebra system and to perform tedious and difficult algebraic manipulations/tasks as well as plotting of graphs for complicated functions to understand their behavior.

Lab-1: Installation of the Scilab, Overview, Basic syntax, Mathematical Operators, Predefined constants, Built in functions. Complex numbers, Polynomials, Vectors, Matrix. Handling these data structures using built in functions

Lab-2: Programming -Functions - Handling .sci files, Programming for Loops - Conditional statements.

Lab-3: Find the roots of the given equations numerically using the Newton-Raphson Method.

Lab-4: Taylor series expansion of some functions.

Lab-5: Fourier series expansion of different wave forms and comparison with the original function

Lab-6: Solving System of Equations using Scilab and Eigen Values and Eigen Vectors of Matrices.

Lab-7: Compute the integral numerically using the trapezoidal rule.

Lab-8: Checking LI and LD of Vectors and Verifying Rank-Nullity Theorem.

Lab-9: Matrix associated with linear Transformations and their corresponding operations.

Lab-10:Orthogonal and Orthonormal Vectors, Gramm Schmidt Orthogonalization process.

Textbooks (For Tutorial sessions):

1. Robert T. Smith and Roland B. Minton, Calculus, 4thEdition, McGraw Hill Education.
2. George B. Thomas and Ross L. Finney, Calculus, 9th Edition, Pearson Education

XXXX **Basic Electrical Electronics Engineering** **Credit: 3+0+1**

SCHEME

<table>
<tr><td>Course Title</td><td colspan="3">Basic Electrical and Electronics Engineering</td><td colspan="3">Course Type</td><td colspan="3">Integrated</td></tr>
<tr><td>Course Code</td><td colspan="3">XXXX</td><td colspan="3">Class</td><td colspan="3">First Year</td></tr>
<tr><td rowspan="6">Instruction delivery</td><td>Activity</td><td>Credits</td><td>Credit Hours</td><td colspan="4" rowspan="2">Total Number of Classes per Semester</td><td colspan="2" rowspan="2">Assessment in Weightage</td></tr>
<tr><td>Lecture</td><td>3</td><td>3</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td rowspan="3">Theory</td><td rowspan="3">Tutorial</td><td rowspan="3">Practical</td><td rowspan="3">Self-study</td><td rowspan="3">CIE</td><td rowspan="3">SEE</td></tr>
<tr><td>Practical</td><td>1</td><td>2</td></tr>
<tr><td>Self-study</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>4</td><td>5</td><td>45</td><td>0</td><td>30</td><td>0</td><td>50%</td><td>50%</td></tr>
<tr><td rowspan="3">Names Course Instructors</td><td>Course Lead:</td><td colspan="8"></td></tr>
<tr><td colspan="3">Theory</td><td></td><td colspan="5">Practical</td></tr>
<tr><td colspan="3"></td><td></td><td colspan="5"></td></tr>
</table>

COURSE OVERVIEW

This course deals with the technological aspects of electricity, especially the basic theorems, laws and application of circuitry and electronic equipment such as diode, Bipolar Junction Transistor and sensors. Electrical and Electronic Engineering is associated in dealing with many of the real-time problems in control and operation of power systems and electrical machines. This field pervades every aspect of handling information, from sensing and acquisition, through communications, networking, switching, processing, and storage.

COURSE OBJECTIVE

To understand semiconductor devices, sensors and transducers with their applications.
To familiarize with basic concepts of Magnetic circuits, Electro magnetism and Electrostatics.
To apply basic electrical and electronics laws or theorems to solve problems
To analyse AC & DC circuits.

COURSE OUTCOMES (COs)

After the completion of this course, the student will be able to:

CO No.	Course Outcomes
CO1	Explain the basics of circuit elements, difference parameters and their relationship for electrical/electronic/magnetic circuits.
CO.2	Apply the acquired knowledge to study basic electrical/electronic/ Electromagnetic circuit.
CO.3	Analyze DC and AC Circuits with different configurations and biasing condition.
CO.4	Develop the electronic/electrical circuits or system to obtain efficient solutions for real life applications.

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO No.	Bloom's Level					
	Remember (BTL1)	Understand (BTL2)	Apply (BTL3)	Analyze (BTL4)	Evaluate (BTL5)	Create (BTL6)
CO.1		√				
CO.2			√			
CO.3				√		
CO.4				√		

PROGRAM OUTCOMES (POs):

PO1	**Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.
PO2	**Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration or sustainable development.
PO3	**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.

PO4	**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.
PO5	**PO5: 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.
PO5	**PO6: 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.
PO7	**PO7: Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.
PO8	**PO8: Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO9	**PO9: 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.
PO10	**PO10: 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 leader in a team, and to manage projects and in multidisciplinary environments.

COURSE ASSESSMENT

Assessment Tools	CIE			Total CIE marks	SEE
	MTE	LAB INT	LAB EXAM		
Integrated	50	25	25	100	100

Assignment, Quiz, Class test, SWAYAM/NPTEL/MOOCs and etc.

CONTENT:

UNIT 1: Circuits Elements (R, L, C), Kirchhoff's Laws, Superposition Principle and theorem, Norton's theorem, Thevenin's Theorem, Voltage source, (definition, characteristics of practical source, equivalent current source) Star-Delta transformation.

UNIT 2:
Flux, mmf, reluctance, analogous electric circuits, simple calculations for composite magnetic circuits. Periodic functions, average &rms values, Steady state behaviors with sinusoidal excitation, phasor representation, reactance and impedance, Series and Parallel A.C. circuits, resonance, power in A.C. circuits, power factor.

UNIT 3: Basic diode concept, different types of rectifier circuits, Zener diode voltage regulation concept Bipolar junction transistors, CB, CE and CC configurations and characteristics.

UNIT 4: Sensor and Transducer Definitions, Criteria to Choose a Sensor, Basic Requirements of a Sensor or Transducer, Classification of Sensors, Analog and Digital Sensors, Biosensors- Advantages and limitations, biosensors for environmental monitoring, biosensors in healthcare applications. Application of network theorem, Application of Diodes, Application of Bipolar Junction Transistor.

References:
Textbook:Basic Electrical Engineering by B.L. Theraja
Additional Reading: IEEE Standards on Electrical Safety, Embedded Systems Security Articles
Reference book
Basic Electrical Engineering, D C. Kulkshreshtha, McGraw, 2012, First edition.
Laboratory courses in Electrical Engg, S G Tarnekar, P K Kharbanda, S B Bodkhe, S D Naik, S. Chand & Co, 2010, Second edition.
Brian R Eggins - Biosensors an Introduction, First edition, John Wiley & Sons Publishers, 1996.
Website link:

- https://www.electrical4u.com/
- https://www.allaboutcircuits.com/

SWAYAM/NPTEL course link:

- https://nptel.ac.in/courses/108108076
- https://nptel.ac.in/courses/108105053

PRACTICAL

Lab 1: To familiarize with Measuring and testing equipment like Multimeter, CRO, Function Generator, Power Supply etc. and also familiarize with bread board, resistors and capacitors etc. Calculate the Resistance value according to Color band and verify the same by measuring through Multimeter.

Lab 2: To verify a) Kirchhoff's Current law and b) Kirchhoff's Voltage law.

Lab 3: To verify the Thevenin's Theorem.

Lab 4: To verify the Norton's Theorem**.**

Lab 5: To plot the V-I characteristics of P-N Junction Diode and calculate the forward and reverse resistance of the diode.

Lab 6: To plot the V-I characteristics and Verification of Regulation action of ZENER Diode.

Lab 7: To verify the working of Half/Full Wave Rectifier Circuit and calculate its efficiency.

Lab 8: To plot the input and output characteristics of Bipolar Junction Transistor (BJT) in Common Emitter connection.

Lab 9: To study the response of LDR and Photodiode to light intensity and implement a light-detection circuit.

Lab 10: To interface a Temperature Sensor (RTD/LM35) with Arduino or NI my DAQ for real-time monitoring

XXXX **Programming for Problem Solving** **Credit:2+1+1**

Course Objectives:

- To learn the fundamentals of computers.
- To understand the various steps in program development.
- To learn the syntax and semantics of the C programming language.
- To learn the usage of structured programming approaches in solving problems.

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1: The student would learn the basic concepts of Computer and acquire various problem solving techniques such as algorithms and flowchart.

CO2: To understand the basic terminology used in programming and able to write, compile and debug programs in 'C' programming language and to develop program logics using decision structures and loop structures.

CO3: To develop program logics using the concept of arrays and arrays of characters.

CO4: To understand the modular techniques such as functions and difference between call by value and call by reference methods.

CO5: Implement and develop small projects using the concept Structures in C programming language.

CO6: Algorithms and Advanced Programming development in different field.

CONTENTS:

UNIT - I: Parts of a computer – Overview of operating systems, assembler, compilers, interpreters and programming languages. Algorithms for exchanging the values of two variables, counting, summation of a set of numbers, factorial computation, sine function computation, generation of the Fibonacci sequence, reversing the digits of an integer, flowchart.

UNIT - II: Lexical elements – Operators - data types – I/O statements – format specifications – control statements – decision making and Loop control structure: while loop, for loop, do-while loop, nested loop, break, continue, case control structure, go to, exit statement

UNIT - III: Array handling in C – declaration – single dimensional arrays, two – dimensional arrays, multidimensional arrays, sorting and searching on single and two dimensional arrays. Array order reversal, string handling function, manipulation on strings..

UNIT - IV: Prototype – declaration - arguments (formal and actual) – return types – types of functions difference between built-in and user-defined functions.

UNIT - V: Declarations - nested structures- array of structures - structure to functions - unions- difference between structure and union. Declarations-nestedstructures-arrayofstructures-structuretofunctions-unions-difference between structure and union.

TEXT BOOKS:

1. Jeri R. Hanly and Elliot B.Koffman, Problem solving and Program Design in C 7th Edition, Pearson
2. B.A. Forouzan and R.F. Gilberg C Programming and Data Structures, Cengage Learning, (3rd Edition)
3. Alexis Leon and Mathews Leon (2001), Introduction to Information Technology, Tata McGraw- Hill.
4. R.G. Dromey (2001), How to Solve it by Computer, Prentice Hall of India.
5. Al Kelley and Ira Pohl (1998), A Book on C Programming in C, 4th Edition, Pearson Education.

6. E. Balagurusamy 7th Edition, Programming ANSI C, McGraw-Hill
7. Brian W. Kernighan and Dennis M. Ritchie, The C programming Language, Prentice-Hall in 1988
8. Byron Gottfried, Programming with C, Schaum's Outline

LIST OF EXPERIMENTS:

LAB 1. C Programming using Simple statements and expressions
LAB 2. Scientific problem-solving using decision making and looping.
LAB 3. Simple programming for one dimensional and two-dimensional arrays.
LAB 4. Solving problems using String functions
LAB 5. Programs with user defined functions – Includes Parameter Passing
LAB 6. Program using Recursive Function and conversion from given program to flow LAB chart.
LAB 7. Program using structures and unions.

TEXT BOOKS

1. Gottfried, Byron S., Programming with C, Tata McGraw Hill
2. Balagurusamy, E., Computing Fundamentals and C Programming, Tata McGraw-Hill

REFERENCE BOOKS

1. Jeri R. Hanly& Elliot P. Koffman, Problem Solving and Program Design in C, Addison Wesley.
2. Yashwant Kanetker, Let us C, BPB
3. Rajaraman, V., Computer Programming in C, PHI

XXXX **Engineering Design and prototype** **Credit: 3+0+1**

COURSE OVERVIEW

This course introduces the fundamental concepts of product design, solid modelling and prototyping. It covers the use of CAD software for 2D and 3D modelling, as well as the principles of additive manufacturing and reverse engineering.

COURSE OBJECTIVE

This course aims to provide students with the fundamental knowledge and skills in solid modeling and prototyping. Students will be able to understand the role of CAD in product design, use CAD software to create 2D and 3D models of objects, apply the principles of additive manufacturing to create prototypes and use reverse engineering techniques to create digital models of existing objects.

COURSE OUTCOMES (COs)

After the completion of this course, the students will be able to:

CO No.	Course Outcomes
CO1	Apply the concept of product design and digital prototyping for designing and developing simple products
CO.2	Construct 2D drawing using sketcher workbench of any parametric CAD software
CO.3	Build 3D solid models using Part workbench of any parametric CAD software
CO.4	Develop prototype using 3D printer / rapid prototyping

BLOOM'S LEVEL OF THE COURSE OUTCOMES

CO No.	Bloom's Level					
	Remember (BTL)	Understand (BTL2)	Apply (BTL3)	Analyze (BTL4)	Evaluate (BTL5)	Create (BTL6)
120.1			√			
120.2			√			
120.3			√			
120.4			√			

PROGRAM OUTCOMES (POs):

PO1	**Engineering knowledge:** To apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified

	needs with appropriate considerations for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life- long learning in the broadest context of technological change

Program specific outcome (PSO)

PSO1	Students are trained to perform tasks related to conversion of mechanical system to automatic system, integrating mechanical system to IoT and cloud-based technologies.
PSO2	Students are practiced to use augmented reality / virtual reality along with different CAE tools for rapid prototyping and additive manufacturing.

COURSE ASSESSMENT

Assessment Tools	CIE			Total CIE marks	SEE (Lab Based)
	MTE	LAB Work	Course Based Project		
Comprehensive	50	25	25	100	100

CONTENTS:

UNIT 1: **Introduction to Product Design:** Role of Computer in Product Design, Introduction to Orthographic Projection, Third vs. First angle projection, multi-view drawing, Development of Surfaces, **Introduction to CAD Softwares:** Parametric Modelling Softwares, Introduction to Solidworks, Introduction to Digital Fabrication, Digital fabrication tools

UNIT 2: Working in 2D environment: Drawing tool: Line, Rectangle, Circle, Arc, Ellipse, Spline, etc., Editing tool: Trim, Extend, Erase, Mirror, etc., Modify tool: Chamfer, Fillet, Copy, Move, etc., Linear, angular dimensions, Dimensioning constraint and Geometrical constraint, Drawing template: prepare drawing template consisting of Name plate boundary lines and projection symbol,

UNIT 3: Working in 3D environment: Creating 3D Solid Models of simple machine parts, Part tool: Extrude, Hole, Revolve, Rib, Sweep, Swept blend, Pattern, etc., Part Editing tool: Trim, Extend, Erase, Mirror, Part Modify tool: Chamfer, Round, Copy, Move, Draft, etc., Intersect 2 solid components by inserting new body option, Boolean operations: Union, subtract, intersection, Assembly modelling and motion analysis of Four Bar Linkage Mechanism (Slider Crank Mechanism), Pipe Vice Assembly, Drafting of 3D Assembly: Generate orthographic projections of the assembly

UNIT 4: Introduction to Additive manufacturing: 3D printing, Rapid prototyping, Fused deposition modeling technique, Materials for 3D Printing, Applications in various fields, File format: STL (Stereo Lithography), conversion of solid model file into STL, 3D printer software: part import, orientation, Parameters, Slicing, processing and printing, **Introduction to Reverse Engineering & 3D scanning:** Stages in the Reverse Engineering, Working principle and operations of 3D scanners, Step by step procedure: 3D scanning, Industrial applications of Reverse Engineering

LIST OF EXPERIMENTS:

1. Demonstration of Orthographic Projection
2. Demonstration of Multi-view drawing
3. Demonstration of surface development
4. Drawing Tools in 2D Environment in Solidworks
5. Editing Tools in 2D Environment
6. Linear, angular dimensions, Dimensioning constraint and Geometrical constraint
7. Part Tools in 3D Environment
8. Part Editing Tools in 3D Environment
9. Boolean operations
10. Introduction to Assembly Modelling and Motion Analysis
11. Drafting of 3D Assembly
12. Simulation of FDM Anatomy of 3D Printer Machine
13. Demonstration of FDM 3 D Printer
14. Simulation of Pre-processing & Post processing in Additive manufacturing
15. Hands on Practice in Converting CAD models into STL files
16. Demonstration of 3D printer software: part import, orientation, Parameters
17. Hands on Practice in Part import and Orientation, Parameters
18. Demonstration of 3D printer software: Slicing, processing and printing
19. Hands on Practice in Slicing, processing and printing
20. Simulation and Demonstration and Hands on Practice of 3D Scanning

TEXT BOOKS

1. N. D. Bhatt (2019), Engineering Drawing, 53rd edition, Charotar Publishing House, 978938035896.

REFERENCE BOOKS

1. C. S. Thorat, Additive manufacturing and 3D printing technology: Principles and Applications, CRC Press; 1st edition, 978-0367436223

2. Prof. Sham Tickoo, Solidworks 2016 For Engineers and Designers, Dreamtech Press, 978-9351198994
3. Solidworks lab manual prepared by Mr. Lavepreet Singh, Department of Mechanical Engineering.
4. Additive manufacturing and 3D printing lab manual prepared by Mr. Shrikant Vidya, Department of Mechanical Engineering.
5. Pradeep Jain, Engineering Graphics and Design, Khanna Book Publishing; 1st edition, 978- 9386173478

WEBSITE LINK:

https://www.solidworkstutorials.com/

XXXX **Big Data Engineering** **Credit:3+0+0**

Course Description:

This course provides foundational knowledge of electronic components, circuits, and devices essential for understanding modern cybersecurity hardware and embedded systems. It covers fundamental principles of electronics, including semiconductors, diodes, transistors, and digital circuits, emphasizing their applications in secure hardware design and embedded security systems used in defense and cyber security infrastructures. The course aims to equip students with the theoretical and practical skills necessary to analyze, design, and troubleshoot basic electronic circuits relevant to cybersecurity hardware UNITs.

Course Objectives:

By the end of this course, students will be able to:

1. Understand the fundamental concepts of electronic components and their operation, including resistors, capacitors, diodes, and transistors.
2. Analyze and design basic analog and digital electronic circuits used in security hardware systems.
3. Comprehend the behavior of semiconductor devices and their role in embedded security applications.
4. Develop practical skills in testing and troubleshooting electronic circuits relevant to cybersecurity hardware UNITs.
5. Recognize the importance of electronic components in the design of secure hardware systems for defense and cyber security applications.
6. Apply basic electronics principles to enhance the security features of embedded devices used in cybersecurity infrastructure.

CONTENTS:

UNIT 1: Introduction to Cyber Security & Data Science, Data Types and Data Collection in Cyber Security, Overview of Big Data Technologies (Hadoop, Spark), Data Storage Solutions (HDFS, NoSQL databases), Cyber Security Data Sources (logs, network traffic, threat intelligence feeds)

UNIT 2: Data Cleaning and Preprocessing, Exploratory Data Analysis (EDA), Visualization Tools (Tableau, Power BI, matplotlib, seaborn), Machine Learning Basics for Threat Detection, Anomaly Detection Techniques, Feature Engineering for Cyber Security Data

UNIT 3: Supervised Learning Algorithms (Decision Trees, Random Forest, SVM), Unsupervised Learning (Clustering, Dimensionality Reduction), Deep Learning applications in Cyber Security, Model Evaluation & Validation, Realtime Data Analytics & Stream Processing

Unit 4: Big Data Pipeline Architecture, Data Ingestion & Processing Frameworks (Apache Kafka, Flink), Security in Big Data Ecosystems (Encryption, Access Control), Log Management & SIEM Integration, Cloud based Big Data Solutions (AWS, Azure, GCP)

XXXX	**Aptitude Skill**	**Credit: 0+0+2**
XXXX	**Yoga (NC)**	**Credit: 0+0+2**

SEMESTER-III

XXXX **Operating Systems** **3+0+0**

<table>
<tr><td>Course Title</td><td colspan="3">Operating Systems</td><td colspan="4">Course Type</td><td colspan="2">Integrated</td></tr>
<tr><td>Course Code</td><td colspan="3">XXXX</td><td colspan="4">Class</td><td colspan="2">B.Tech</td></tr>
<tr><td rowspan="6">Instruction delivery</td><td>Activity</td><td>Credits</td><td>Credit Hours</td><td colspan="4">Total Number of Classes per Semester</td><td colspan="2">Assessment in Weightage</td></tr>
<tr><td>Lecture</td><td>3</td><td>3</td><td rowspan="4">Theory</td><td rowspan="4">Tutorial</td><td rowspan="4">Practical</td><td rowspan="4">Self-study</td><td rowspan="4">CIE</td><td rowspan="4">SEE</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td></tr>
<tr><td>Practical</td><td>0</td><td>0</td></tr>
<tr><td>Self-study</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>3</td><td>3</td><td>45</td><td>0</td><td>30</td><td>0</td><td>50%</td><td>50%</td></tr>
<tr><td rowspan="3">Names Course Instructors</td><td>Course Lead:</td><td colspan="8"></td></tr>
<tr><td colspan="3">Theory</td><td></td><td colspan="5">Practical</td></tr>
<tr><td colspan="3"></td><td></td><td colspan="5"></td></tr>
</table>

Course Overview

This theory-based course explores operating system structures, processes, memory management, and file systems, with emphasis on secure implementations relevant to defence applications like real-time systems and cyber-resilient kernels. It equips students to handle concurrency and resource allocation in high-stakes scenarios such as military networks and AI-driven defence platforms.

Course Objectives

- Introduce core OS functions, structures, and services for modern computing systems.
- Explain process/thread management, scheduling, and synchronization techniques.
- Analyze memory management, virtual memory, and file systems for efficiency and security.
- Cover deadlock handling and I/O systems with defence-oriented security considerations.

Course Outcomes

Outcome	**Description**	**Bloom's Level**
CO1	Understand OS structures, processes, threads, and inter-process communication.	K2 (Understand)
CO2	Apply CPU scheduling algorithms and evaluate their performance in defence scenarios.	K3 (Apply)
CO3	Analyze deadlock prevention, memory management schemes, and virtual memory concepts.	K4 (Analyze)
CO4	Evaluate file systems, I/O management, and security mechanisms in OS kernels.	K5 (Evaluate)
CO5	Design basic OS solutions for secure, concurrent systems in AI/cyber defence contexts.	K6 (Create)

Bloom's Revised Taxonomy structures learning outcomes hierarchically for measurable assessment in technical courses like OS.

Level	Code	Action Verbs	Cognitive Focus
1	K1	Recall, List	Basic facts (OS structures)
2	K2	Explain, Describe	Concepts (process states)
3	K3	Apply, Implement	Algorithms (scheduling)
4	K4	Analyze, Differentiate	Problems (deadlocks)
5	K5	Evaluate, Judge	Security (file protection)
6	K6	Design, Develop	Solutions (secure kernels)

Program Outcomes Mapping

	Program Outcome Description
PO1	Apply maths/science/engineering fundamentals to defence tech problems.
PO2	Identify/analyze complex defence cyber threats using first principles.
PO3	Design secure AI/cyber systems for national security applications.
PO4	Investigate defence tech challenges with research literature.
PO5	Use modern tools for cyber defence simulations/modelling.
PO6	Apply engineering solutions for sustainable defence tech.
PO7	Understand defence tech impacts on society/security/environment.
PO8	Apply ethical principles in classified defence projects.
PO9	Function effectively in multidisciplinary defence teams.
PO10	Communicate defence tech solutions to stakeholders.
PO11	Demonstrate lifelong learning in evolving cyber threats.
PO12	Lead/entrepreneur in defence tech innovation/startups.

COURSE ASSESSMENT

Assessment Tools	CIE			Total	
	MTE	LAB INT	LAB		

			EXAM	CIE marks	SEE
Integrated	**50**	**25**	**25**	**100**	**100**

Assignment, Quiz, Class test, SWAYAM/NPTEL/MOOCs and etc.

CONTENTS (UNIT-WISE, 45 HOURS)

UNIT 1: OS Introduction: OS structures (monolithic, microkernel, hybrid for defence RTOS), system calls, processes/threads, IPC (semaphores, pipes with secure channels). **(8 hrs)**

UNIT 2: Process Scheduling: CPU scheduling algorithms (FCFS, SJF, Round Robin, Priority), multi-level queues. **(10 hrs)**

UNIT 3: Deadlocks & Synchronization: Deadlock characterization, prevention, Banker's algorithm, critical sections. **(9 hrs)**

UNIT 4: Memory Management: Paging, segmentation, virtual memory, page replacement (FIFO, LRU), demand paging. **(10 hrs)**

UNIT 5: File & I/O Systems: File organization, directory structures, disk scheduling (SCAN, C-SCAN), security/protection. **(8 hrs)**

Bibliography

1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, *Operating System Concepts*, 10th Ed., Wiley, 2018.
2. Andrew S. Tanenbaum, *Modern Operating Systems*, 4th Ed., Pearson, 2014.
3. D.M. Dhamdhere, *Operating Systems: A Concept-Based Approach*, 3rd Ed., McGraw-Hill, 2017.

XXXX Data Structures and Database Management Systems 3+0+0

Course Title	Data Structures and Database Management Systems			**Course Type**	Integrated
Course Code	XXXX			**Class**	B.Tech
Instruction delivery	Activity	Credits	Credit Hours	Total Number of Classes per Semester	Assessment in Weightage
	Lecture	3	3		

				Theory	Tutorial	Practical	Self-study	CIE	SEE
	Tutorial	0	0						
	Practical	0	0						
	Self-study	0	0						
	Total	3	3	50	0	0	0	**50%**	**50%**
Names Course Instructors	**Course Lead:**								
	Theory				Practical				

Course Overview

Data Structures and Database Management Systems is a foundational computing course that covers efficient data organization and storage in relational databases. The syllabus includes algorithmic thinking, abstract data types, searching and sorting techniques, trees, graphs, hashing, relational modeling, SQL, normalization, indexing, query processing, transactions, concurrency control, and recovery concepts. The course

aligns with standard undergraduate topics such as arrays, linked lists, stacks, queues, searching, sorting, graphs, trees, and algorithm efficiency. The DBMS component covers RDBMS concepts, SQL, relational algebra, ER modeling, normalization, file structures, indexing, query processing, transactions, concurrency control, and recovery systems.

Course Objectives

After completing this course, students should be able to:

- Understand the role of abstract data types, algorithm design, and complexity analysis in developing efficient software solutions.
- Apply linear and non-linear data structures for storing, processing, and retrieving data efficiently in computing applications.
- Design and implement relational database schemas using ER modeling, normalization, and structured query language.
- Explain physical and logical aspects of database systems including storage structures, indexing, query processing, and optimization.
- Analyze transaction management, concurrency control, and recovery mechanisms for reliable database operation.
- Integrate appropriate data structure and database techniques in problem solving and application development.

Course Outcomes (COs)

On successful completion of the course, students will be able to:

CO Code	Course Outcome	Bloom's Level
CO1	Explain abstract data types, asymptotic notations, and the representation of arrays and linked lists.	Understand (L2)
CO2	Implement stacks, queues, linked lists, trees, graphs, and hashing techniques to solve computational problems.	Apply (L3)

CO3	Analyze searching and sorting algorithms and select suitable data structures for given applications.	Analyze (L4)
CO4	Design relational database schemas using ER modeling, relational algebra concepts, normalization, and SQL.	Create (L6)
CO5	Apply indexing, query processing, and query optimization concepts to improve database performance.	Apply (L3)
CO6	Explain and analyze transactions, concurrency control, serializability, and recovery mechanisms in DBMS.	Analyze (L4)

Bloom's Revised Taxonomy

The course outcomes are framed using Bloom's Revised Taxonomy levels from understanding to creation, enabling a progression from conceptual clarity to implementation, analysis, and design competence in computing systems.

Level	Description	Course Relevance
L1 Remember	Recall definitions, terminology, syntax, and properties	Data types, SQL keywords, tree/graph terminology
L2 Understand	Explain concepts and relationships	ADT, complexity, normalization, concurrency concepts
L3 Apply	Use methods and algorithms in familiar situations	Implement stacks, queues, trees, SQL queries, indexing
L4 Analyze	Differentiate, compare, and evaluate alternatives	Sorting/searching analysis, transaction schedules
L5 Evaluate	Justify choices based on criteria	Select data structures or schema refinements
L6 Create	Design or build new artifacts	Database schema design and integrated application solutions

Detailed Contents

Module I: Foundations of Data Structures

- Basic terminology and elementary data organization.
- Algorithms, efficiency, time and space complexity, asymptotic notations: Big Oh, Big Theta, and Big Omega.
- Abstract Data Types (ADT) and their role in software design.
- Arrays: single-dimensional and multidimensional arrays, row-major and column-major representation, index formulae, sparse matrices, and applications.

Module II: Linked Structures, Stacks, and Queues

- Singly, doubly, and circular linked lists; insertion, deletion, and traversal operations.
- Polynomial representation and operations using linked structures.

- Stacks: ADT, array and linked implementations, push and pop operations, prefix/postfix expressions, postfix evaluation.
- Recursion and iteration, tail recursion, recursion removal, and problem solving examples such as binary search, Fibonacci, and Tower of Hanoi.
- Queues: array and linked implementations, circular queue, deque, and priority queue.

Module III: Searching, Sorting, and Hashing

- Sequential search, index sequential search, and binary search.
- Hashing and collision resolution techniques.
- Sorting methods: insertion sort, selection sort, bubble sort, quick sort, merge sort, heap sort, and radix sort.
- Comparative study of sorting and searching techniques for practical problem solving.

Module IV: Trees and Graphs

- Tree terminology, binary trees, strict and complete binary trees, binary search trees, threaded binary trees, AVL trees, B-trees, and binary heaps.
- Tree traversals: inorder, preorder, postorder, and tree construction from traversal sequences.
- Graph terminology, adjacency matrix and adjacency list representations.
- Graph traversal using breadth-first search and depth-first search; connected components, spanning trees, minimum spanning trees using Prim's and Kruskal's algorithms, transitive closure, and shortest path algorithms including Warshall and Dijkstra.

Module V: Introduction to Database Management Systems

- Overview of database systems and relational DBMS.
- Structured Query Language (SQL) and relational data handling.
- Relational algebra and entity-relationship modeling for conceptual database design.
- Relational database design and normalization concepts.

Module VI: Database Design and Implementation

- Data analysis and schema design for database applications.
- Application development and case studies using relational databases.
- Storage and file structures in database systems.
- Indexing and hashing methods in DBMS.

Module VII: Query Processing and Optimization

- Query processing fundamentals.
- Query optimization techniques and performance-oriented database design.
- Role of physical organization in efficient retrieval.

Module VIII: Transaction Management and Recovery

- Transactions, serializability, and recoverability.
- Concurrency control mechanisms.
- Recovery systems and reliability in DBMS.
- Practical significance of ACID-oriented transaction management in multi-user database applications.

Suggested Pedagogy

- Lectures for conceptual understanding of data structures and database theory.
- Tutorial sessions for algorithm tracing, SQL practice, and schema design.
- Programming assignments for implementation of core data structures.
- Laboratory exercises using C/C++/Java/Python for data structures and MySQL/PostgreSQL for DBMS applications.
- Mini-projects integrating suitable data structures with database-backed applications.

Program Specific Outcomes (PSO) Mapping

- PSO1: Apply data structures in software development.
- PSO2: Design and manage efficient databases.

Course Outcomes to PO Mapping

The following mapping uses a standard three-level correlation scheme: 1 = Low, 2 = Moderate, 3 = High. NBA-oriented academic frameworks commonly use Program Outcomes and Program Specific Outcomes for outcome-based education and attainment mapping.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	1	-	-	-	-	-	-	1
CO2	3	3	2	1	3	-	-	-	-	-	-	2
CO3	3	3	2	2	2	-	-	-	-	-	-	2
CO4	3	3	3	2	3	-	-	-	-	1	-	2
CO5	2	3	2	2	3	-	-	-	-	-	-	2
CO6	3	3	1	2	2	-	-	1	-	-	-	2

Indicative Program Outcomes

- PO1: Engineering knowledge
- PO2: Problem analysis
- PO3: Design/development of solutions
- PO4: Investigations of complex problems
- PO5: Modern tool usage
- PO6: The engineer and society
- PO7: Environment and sustainability
- PO8: Ethics
- PO9: Individual and team work
- PO10: Communication
- PO11: Project management and finance
- PO12: Life-long learning

Course Outcomes to PSO Mapping

The following PSO mapping is indicative for Computer Science and Engineering programs.

CO / PSO	PSO1: Computing Foundations	PSO2: Software and Data-Centric System Development	PSO3: Problem Solving for Interdisciplinary Applications
CO1	3	1	1
CO2	3	2	2
CO3	3	2	2
CO4	2	3	2
CO5	2	3	2
CO6	2	3	1

Program Outcomes Mapping Rationale

The syllabus strongly supports PO1 and PO2 because students learn core computing knowledge and analyze performance, correctness, and design alternatives for algorithms and databases. It also contributes significantly to PO3 and PO5 because students design database schemas and use programming and database tools for implementation. The course moderately supports PO4 through analytical study of algorithm behavior, transaction schedules, and recovery strategies. It supports PO12 by encouraging students to adapt to evolving computing technologies and advanced data management practices.

Assessment Pattern

Assessment Tools	CIE			Total CIE marks	SEE
	MTE	LAB INT	LAB EXAM		
Integrated	50	0	25	100	100

Assignment, Quiz, Class test, SWAYAM/NPTEL/MOOCs and etc.

Bibliography

1. Aaron M. Tenenbaum, Yedidyah Langsam, and Moshe J. Augenstein, *Data Structures Using C and C++*, PHI Learning Private Limited.
2. Ellis Horowitz and Sartaj Sahni, *Fundamentals of Data Structures*, Galgotia Publications.
3. Seymour Lipschutz, *Data Structures*, Schaum's Outline Series, Tata McGraw-Hill.
4. Reema Thareja, *Data Structures Using C*, Oxford Higher Education.
5. Michael T. Goodrich, Roberto Tamassia, and David M. Mount, *Data Structures and Algorithms in C++*, Wiley India.
6. Abraham Silberschatz, Henry F. Korth, and S. Sudarshan, *Database System Concepts*, 6th Edition, McGraw-Hill Education.
7. Raghu Ramakrishnan and Johannes Gehrke, *Database Management Systems*, McGraw-Hill.
8. Ramez Elmasri and Shamkant B. Navathe, *Fundamentals of Database Systems*, Pearson.
9. Hector Garcia-Molina, Jeffrey D. Ullman, and Jennifer Widom, *Database Systems: The Complete Book*, Pearson.
10. C. J. Date, *An Introduction to Database Systems*, Pearson.

XXXX **COMPUTER ARCHITECTURE AND COMPUTER NETWORKS** **3+0+0**

Course Overview

This course introduces the fundamentals of computer architecture and computer networks. It covers digital computer organization, instruction sets, data representation, memory hierarchy, pipelining, and multiprocessor concepts along with networking basics, protocol layers, data transmission, switching, routing, transport, and application-layer services.

Course Objectives

- To introduce the basic organization and architectural concepts of computers.

- To develop understanding of instruction set design, CPU organization, memory systems, and I/O organization.
- To explain computer arithmetic, pipelining, RISC/CISC concepts, and multiprocessor fundamentals.
- To build knowledge of networking models, physical and data link layers, network layer functions, transport mechanisms, and application-layer protocols.

Course Outcomes

1. CO1: Explain the functional units, instruction cycles, and basic organization of computer systems.
2. CO2: Analyze data representation, computer arithmetic, and microprogrammed control techniques.
3. CO3: Describe memory organization, cache techniques, and I/O organization in computer systems.
4. CO4: Explain pipelining, RISC/CISC concepts, and multiprocessor organization.
5. CO5: Understand networking fundamentals, OSI/TCP-IP layers, routing, transport services, and common network applications.

Bloom's Revised Taxonomy

CO	Bloom Level	Action Focus
CO1	Remember, Understand	Define, explain
CO2	Apply, Analyze	Compute, analyze
CO3	Understand, Apply	Describe, compare
CO4	Analyze, Evaluate, Create	Differentiate, design
CO5	Understand, Apply, Analyze	Explain, interpret, compare

Syllabus Contents

Unit I: Computer Fundamentals and Organization: Digital computer basics, block diagram, computer organization vs. architecture, register transfer language, bus and memory transfers, arithmetic and logic micro-operations, instruction codes, registers, timing and control, instruction cycle, input-output and interrupt concepts. Control Unit and CPU: Microprogrammed control, control memory, address sequencing, microprogram examples, general register organization, instruction formats, addressing modes, data transfer and manipulation, stack organization, and program control.

Unit II: Data Representation and Arithmetic: Data types, complements, fixed-point and floating-point representation, addition, subtraction, multiplication and division algorithms, floating-point arithmetic operations, and decimal arithmetic unit. Memory and I/O Organization: Input-output interfaces, asynchronous data transfer, modes of transfer, priority interrupt, direct memory access, memory hierarchy, main memory, auxiliary memory, associative memory, and cache memory.

Unit III: Advanced Architecture: CISC and RISC characteristics, parallel processing, pipelining, arithmetic and instruction pipeline, vector processing, array processors, multiprocessors, interconnection structures, interprocessor communication, synchronization, and cache coherence. Computer Networks Foundations: Introduction to computer networks, network hardware and software, transmission media, network topologies, OSI and TCP/IP models, services and protocols, analog and digital data transmission, and switching techniques.

Unit IV: Data Link and Network Layer: Framing, error detection and correction, flow control, channel allocation, MAC protocols, LAN standards, bridges and switches, logical addressing, IP, CIDR, ARP, RARP, DHCP, ICMP, routing, forwarding, and delivery. Transport and

Application Layers: Transport services, multiplexing and demultiplexing, reliable data transfer, congestion control, socket programming basics, application layer protocols, DNS, SMTP, HTTP, FTP, and network security basics.

Program Outcomes Mapping

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	1	2
CO2	3	3	2	2	2
CO3	3	2	2	3	2
CO4	3	3	3	2	3
CO5	2	2	2	2	3

PSO Mapping

CO	PSO1	PSO2	PSO3
CO1	2	3	1
CO2	3	2	1
CO3	2	3	1
CO4	3	3	2
CO5	2	2	3

Bibliography

Computer Architecture

1. Patterson, D. A., & Hennessy, J. L., *Computer Organization and Design: The Hardware/Software Interface* (RISC-V/MIPS editions).
2. Stallings, W., *Computer Organization and Architecture*, Pearson.
3. Course notes / slides from “Computer Architecture” MOOCs and university offerings (e.g., CMU, edX).
4. M. Morris Mano, Computer System Architecture, Pearson.
5. William Stallings, Computer Organization and Architecture, Pearson.
6. Andrew S. Tanenbaum and Todd Austin, Structured Computer Organization, Pearson.

Computer Networks

1. Kurose, J. F., & Ross, K. W., *Computer Networking: A Top-Down Approach*, Pearson.
2. Tanenbaum, A. S., *Computer Networks*, Pearson.
3. Behrouz A. Forouzan, Data Communications and Networking, McGraw Hill.
4. James F. Kurose and Keith W. Ross, Computer Networking: A Top-Down Approach, Pearson.
5. Larry L. Peterson and Bruce S. Davie, Computer Networks: A Systems Approach, Morgan Kaufmann.

QUANTUM MECHANICS

Course Overview

This course introduces the fundamental principles of quantum mechanics and their applications to microscopic systems. It covers the historical development of quantum theory, wave-particle duality, the Schrödinger equation, operator formalism, angular momentum, atomic systems, approximation methods, and elementary applications relevant to modern physics and engineering.

Course Objectives

- To develop an understanding of the conceptual foundations of quantum theory.
- To introduce mathematical tools used to describe quantum states and observables.
- To enable students to solve standard quantum mechanical problems.
- To build familiarity with atomic systems, approximation methods, and physical interpretation of results.

Course Outcomes

6. CO1: Explain the postulates of quantum mechanics, wave-particle duality, and the probabilistic interpretation of the wave function.
7. CO2: Solve the Schrödinger equation for standard one-dimensional systems and interpret bound and scattering states.
8. CO3: Apply operator formalism, commutation relations, and uncertainty principles to quantum systems.
9. CO4: Analyze angular momentum, spin, and the hydrogen atom using quantum mechanical methods.
10. CO5: Use approximation techniques and perturbation ideas to study simple quantum systems.

Bloom's Revised Taxonomy

CO	Bloom Level	Action Focus
CO1	Remember, Understand	Define, explain
CO2	Apply, Analyze	Solve, interpret
CO3	Understand, Apply, Analyze	Use, derive, compare
CO4	Analyze, Evaluate	Examine, discuss
CO5	Apply, Analyze, Create	Compute, extend, model

Syllabus Contents

- Unit I: Introduction to Quantum Mechanics: Origin of quantum theory, black-body radiation, photoelectric effect, Compton effect, de Broglie hypothesis, matter waves, wave packet, uncertainty principle, and probabilistic interpretation of wave function.

- Unit II: Schrödinger Equation: Time-dependent and time-independent Schrödinger equations, operators, eigenvalues and eigenfunctions, normalization, expectation values, and continuity equation.
- Unit III: One-Dimensional Problems: Particle in a box, finite potential well, tunneling through barriers, step potential, harmonic oscillator basics, and reflection and transmission coefficients.
- Unit IV: Operator Formalism: Linear vector space, Dirac notation, Hermitian operators, commutators, uncertainty relations, simultaneous observables, and matrix representation of operators.
- Unit V: Angular Momentum and Spin: Orbital angular momentum, angular momentum commutation relations, ladder operators, spin angular momentum, addition of angular momenta, and Pauli exclusion principle.
- Unit VI: Hydrogen Atom: Central potential problem, radial equation, quantum numbers, energy spectrum, degeneracy, and qualitative discussion of atomic orbitals.
- Unit VII: Approximation Methods: Time-independent perturbation theory, non-degenerate and degenerate cases, variational method, WKB idea, and applications to simple systems.
- Unit VIII: Advanced Applications: Identical particles, symmetric and antisymmetric wave functions, introduction to quantum statistics, and brief overview of applications in atoms, molecules, and solid-state systems.

Program Outcomes Mapping

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	1	1
CO2	3	3	2	2	2
CO3	3	3	2	3	2
CO4	3	3	3	2	2
CO5	3	3	3	3	2

PSO Mapping

CO	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	3	1
CO3	3	3	2
CO4	3	3	2
CO5	2	3	3

Bibliography

- David J. Griffiths and Darrell F. Schroeter, Introduction to Quantum Mechanics, Cambridge University Press.
- J. J. Sakurai and Jim Napolitano, Modern Quantum Mechanics, Cambridge University Press.
- N. Zettili, Quantum Mechanics: Concepts and Applications, Wiley.
- R. Shankar, Principles of Quantum Mechanics, Springer.
- C. Cohen-Tannoudji, B. Diu, and F. Laloë, Quantum Mechanics, Wiley.
- Paul A. M. Dirac, The Principles of Quantum Mechanics, Oxford University Press.

BACHELOR OF TECHNOLOGY IN DEFENCE TECHNOLOGY
AI & CYBER SECURITY OF DATA VISUALIZATION - R PROGRAMMING / POWER BI

Course Overview

This course introduces students to data visualization using R Programming and Power BI with an emphasis on applications relevant to AI and Cyber Security. It covers data preparation, exploratory analysis, graphical presentation, interactive dashboards, reporting, and the responsible use of visual analytics for security and defence-oriented decision support.

Course Objectives

- To introduce the fundamentals of data visualization and visual analytics.
- To enable students to use R programming for data cleaning, analysis, and chart creation.
- To develop proficiency in Power BI for dashboarding, reporting, and interactive visualization.
- To expose students to data-driven insights for AI and cyber security use cases.
- To build competence in selecting appropriate visual forms for communication and decision-making.

Course Outcomes

11. CO1: Explain the principles of data visualization, chart selection, and visual storytelling.
12. CO2: Use R programming to import, clean, transform, and visualize data.
13. CO3: Create analytical plots and graphical summaries for AI and cyber security datasets.
14. CO4: Design interactive dashboards and reports using Power BI.
15. CO5: Evaluate visual analytics solutions and communicate insights for defence technology applications.

Bloom's Revised Taxonomy

CO	Bloom Level	Action Verbs
CO1	Understand	explain, identify
CO2	Apply	import, clean, plot
CO3	Analyze	compare, interpret, summarize
CO4	Create	design, build, publish
CO5	Evaluate	assess, justify, communicate

Syllabus Contents

- Unit I: Introduction to data visualization, visual perception, graphical variables, chart selection, design principles, and ethics in visualization.
- Unit II: R programming basics, data types, vectors, lists, data frames, importing data, preprocessing, and packages for visualization.
- Unit III: Data visualization in R, base graphics, ggplot2, histograms, bar charts, line charts, scatter plots, box plots, heatmaps, and correlation plots.
- Unit IV: Statistical visualization for AI and cyber security, trend analysis, anomaly detection visuals, time-series plots, and summary dashboards using R.
- Unit V: Power BI fundamentals, data connection, data modeling, Power Query, DAX basics, chart types, slicers, filters, and report design.
- Unit VI: Interactive dashboards in Power BI, drill-down, drill-through, bookmarks, KPIs, publishing, sharing, and R visuals in Power BI.
- Unit VII: Case studies in AI and cyber security, threat trend visualizations, incident dashboards, model performance charts, and security monitoring visuals.
- Unit VIII: Mini project on defence-oriented data visualization using R and Power BI with documentation and presentation.

Program Outcomes Mapping

CO	PO1	PO2	PO3	PO4	PO5
CO1	2	3	2	2	1
CO2	3	3	2	2	2
CO3	3	3	3	3	2
CO4	2	3	3	3	2
CO5	2	2	3	3	3

PSO Mapping

CO	PSO1	PSO2	PSO3
CO1	2	2	1
CO2	3	2	1
CO3	3	3	2
CO4	2	3	2
CO5	2	3	3

Bibliography

- Hadley Wickham and Garrett Grolemund, R for Data Science, O'Reilly Media.
- Winston Chang, R Graphics Cookbook, O'Reilly Media.
- Hadley Wickham, ggplot2: Elegant Graphics for Data Analysis, Springer.
- Micheal Alexander and John Walkenbach, Microsoft Power BI for Dummies, Wiley.
- Maria L. Roldan and others, Power BI Data Analysis and Visualization, Packt Publishing.
- James F. Kurose and Keith W. Ross, Computer Networking: A Top-Down Approach, Pearson.
- Stallings, William, Computer Security: Principles and Practice, Pearson.

SYLLABUS

BACHELOR OF TECHNOLOGY IN DEFENCE TECHNOLOGY

AI & CYBER SECURITY: DEEP LEARNING AND NEURAL NETWORKS

Course Overview

This course introduces the principles of artificial intelligence, neural networks, deep learning, and their use in cyber security and defence applications. It emphasizes model building, security-focused AI use cases, adversarial threats, and responsible deployment in defence environments.

Course Objectives

- Build a foundation in neural networks, learning paradigms, and deep learning workflows.
- Introduce cyber security applications of AI such as intrusion detection, malware analysis, phishing detection, and anomaly detection.
- Develop the ability to analyze network data and security problems using machine learning methods.
- Expose students to adversarial attacks, model robustness, and ethical issues in defence AI systems.
- Prepare students for advanced study and project work in AI-enabled cyber defence.

Course Outcomes

16. CO1: Explain the fundamentals of AI, neural networks, and deep learning architectures.
17. CO2: Implement core learning concepts including activation functions, loss functions, backpropagation, and optimization.
18. CO3: Apply deep learning models to cyber security tasks such as intrusion detection and malware classification.
19. CO4: Analyze the security risks of AI systems including adversarial examples, data poisoning, and model evasion.
20. CO5: Design a basic AI-enabled cyber security solution for a defence-oriented problem with appropriate evaluation metrics.

Bloom's Revised Taxonomy

CO	Bloom Level	Action Words
CO1	Remember, Understand	Define, explain
CO2	Apply, Analyze	Implement, compute
CO3	Apply, Analyze	Detect, classify
CO4	Analyze, Evaluate	Assess, compare

CO5	Create, Evaluate	Design, validate

Syllabus Contents

- Unit I: Introduction to AI and Learning: Historical perspective of AI, machine learning vs deep learning, biological neuron, perceptron, learning rules, supervised, unsupervised, and reinforcement learning, overview of defence applications.
- Unit II: Neural Networks: Artificial neural networks, multilayer perceptron, activation functions, forward propagation, error functions, gradient descent, backpropagation, regularization, and model selection.
- Unit III: Deep Learning Architectures: Deep feedforward networks, convolutional neural networks, recurrent neural networks, LSTM and GRU basics, optimization methods, dropout, batch normalization, transfer learning.
- Unit IV: AI for Cyber Security: Intrusion detection, malware classification, phishing detection, spam filtering, anomaly detection, security analytics, log analysis, and threat intelligence applications.
- Unit V: Adversarial AI and Defence: Adversarial machine learning, evasion and poisoning attacks, model robustness, secure model deployment, privacy concerns, explainable AI, and ethics in defence systems.
- Unit VI: Practical Deployment: Data preprocessing, feature engineering, model evaluation, precision, recall, F1-score, ROC-AUC, confusion matrix, deployment pipeline, and case studies in cyber defence.

Program Outcomes Mapping

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	1	1
CO2	3	3	2	2	2
CO3	2	3	3	3	2
CO4	2	3	2	3	3
CO5	3	3	3	3	3

PSO Mapping

CO	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	3	1
CO3	3	3	2

CO4	2	3	3
CO5	3	3	3

Bibliography

- Goodfellow, Bengio and Courville, Deep Learning, MIT Press.
- Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer.
- Simon Haykin, Neural Networks and Learning Machines, Pearson.
- Yoshua Bengio, Ian Goodfellow, and Aaron Courville, Deep Learning, MIT Press.
- William Stallings, Cryptography and Network Security, Pearson.
- B. A. Forouzan, Data Communications and Networking, McGraw Hill.
- Fei Hu and Xiaojun Lin, AI, Machine Learning and Deep Learning: A Security Perspective, CRC Press.