Ref: MITM/ECE/CBS/2023-24/001

MAHARAJA INSTITUTE OF TECHNOLOGY MYSORE

Autonomous Institution Affiliated to VTU

Competency Based Syllabus (CBS) for Electronics and Communication Engineering

(Under Outcome Based Education (OBE) and

Choice-Based Credit System (CBCS))

Offered from 5th to 6th Semesters of Study in

Partial Fulfillment for the Award of Bachelor's Degree in

Electronics and Communication Engineering

2023 Scheme

Scheme Effective from the academic year 2023-24

General Contents of Competency Based Syllabus Document

Index	Description

5th Semester	**Professional Course (PC)** **COMPUTER COMMUNICATION NETWORK**	**M23BEC501**

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Computer Science Concepts	• Understanding of Computer Systems with basic computer operations, including how computers process and store data. • Knowledge of programming, ideally in a language like Python, C, or Java, to grasp how data is manipulated and transmitted through software.
2	Mathematics	• Understanding of set theory, logic and combinatorics which are foundational for grasping network algorithms and protocols. • Understanding Bandwidth and Throughput: Ability to interpret and calculate network performance metrics. • Useful for understanding concepts such as error detection, correction, and network performance metrics.
3	Basic Networking Concepts	• Knowledge of the OSI (Open Systems Interconnection) and TCP/IP (Transmission Control Protocol/Internet Protocol) models and how they conceptualize data communication layers. • Understanding of basic networking hardware like routers, switches, and modems, as well as protocols like TCP and UDP.
4	Basics of communication systems	• Knowledge of data and voice modulation techniques pertaining to long distance communication. Noise elimination techniques in communication channels and systems.
5	Programming skills	• Basic knowledge of C and C++ is required to understand the program flow if used in practical component

2. Competencies

S/L	Competency	KSA Description
1	Data Communication	**Knowledge:** Understanding of Network Types and Transmission Media: Students will gain comprehensive knowledge about different types of networks (e.g., LANs, WANs), guided transmission media (like fiber optics and twisted pair cables), and wireless transmission methods. **Skills:** Students will gain the skill to analyze different types of transmission media and communication technologies and select the most suitable option based on factors like bandwidth requirements, distance, and environmental conditions. **Attitudes:** Students will develop a deeper appreciation for the complexity and interrelated nature of modern communication systems.
2	Data Link Layer in Communication System	**Knowledge:** Students will gain knowledge about the specific functions of the Data Link Layer, including link-layer addressing (e.g., MAC addresses), data link control services, and various protocols that operate at this layer. **Skills:** Students will acquire the skill to implement and analyze various error detection and correction techniques, such as block coding. **Attitudes:** Students will develop an appreciation for the importance of error detection and correction mechanisms.
3	Medium Access Control in Communication System	**Knowledge:** Students will gain a thorough understanding of different network access methods, including Random Access (like CSMA/CD) and Controlled Access (like token passing). They will also learn about Ethernet protocols for wired LANs, the architecture and MAC sub-layer of IEEE 802.11 for wireless LANs, and the role of connecting devices and Virtual LANs (VLANs) in network design. **Skills:**

		Students will acquire the skill to design, implement, and manage both wired and wireless LANs. **Attitudes:** Students will develop an appreciation for the diversity of LAN technologies and their evolution over time.
4	Network Layer in Communication System	**Knowledge:** Understanding of the network layer's role in providing services such as routing, packet switching, and addressing. **Skills:** Acquire the skill to configure IPv4 addressing for network devices, design sub-netting schemes, and troubleshoot issues related to packet switching. **Attitudes:** Develop an appreciation for the critical role that efficient packet switching and proper addressing play in network performance and reliability.
5	Transport Layer in Communication System	**Knowledge:** Understanding of the fundamental transport-layer protocols: TCP (Transmission Control Protocol) and UDP (User Datagram Protocol). **Skills:** Acquire practical skills in configuring network applications to use TCP or UDP, as well as in analyzing and troubleshooting network traffic. **Attitudes:** Students will develop an appreciation for the balance between reliability and efficiency in network communications.

3. Syllabus

COMPUTER COMMUNICATION NETWORK **SEMESTER – V**			
Course Code	**M23BEC501**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**3:0:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course Objectives: This course will enable students to

1. Layering architecture of OSI reference and TCP/IP model.
2. Elaborates the background concepts, and functionalities of application layer, transport layer, and network layer.
3. Study and analyze the flow and error control schemes.
4. Present ample details about the protocols, technologies, algorithms and standards that are used by each layer as it relates to the internet.
5. Overview of LAN concept, link layer, connecting LANs and connecting devices.

Module -1

Data Communication: Introduction to Data Communication, Network, Network types, The Physical layer: The Theoretical Basis for Data Communication, Guided Transmission Media, Wireless Transmission Section, Communication Satellites, The Public Switched Telephone Network, The Mobile Telephone System, Cable Television.

Module -2

Data Link Layer: Introduction, Link-Layer addressing, Data link Control: DLC services, Data-Link layer Protocols, Error detection and correction: Introduction, Block Coding.

Module -3

Medium Access Control: Random Access, Controlled Access. Wired LANs: Ethernet Protocol, Wireless LANs: Introduction, IEEE 802.11-Architecture, MAC Sub layer, Connecting devices and Virtual LANS.

Module -4

Network Layer: Network –Layer services, Packet Switching, IPV4 address Network layer Protocols: Internet Protocol.MAN/WAN applications.

Module -5
Transport layer: Introduction, UDP, Transport-layer protocols, Transport-layer protocols: TCP services, TCP features, Segment, Application Layer: Introduction.
TEXTBOOKS: 1. Data Communication and Networking, B Forouzan, 5th Ed, ISBN-13:978-1-25-9006475-3 2. Computer Networks, Andrew S. Tanenbaum, 4th, EEE **REFERENCE BOOKS:** 1. Computer Networks, James F. Kurose, Keith W. Ross: Pearson education, 2nd Edition,
2. Introduction to Data communication and Networking, Wayne Tomasi: Pearson education 3. S. Keshav, "An Engineering Approach on Computer Networking", Addison Welsey. 4. Wayne Tomasi "Introduction to Data Communications and Networking" Pearson. 5. A.S. Tanenbaum, "Computer Networks", PHI. **E Books:** 1. https://www.e-booksdirectory.com/details.php?ebook=10361 2. https://www.e-booksdirectory.com/details.php?ebook=7190 **MOOCs:** 1. http://nptel.ac.in/video.php?subjectId=106105081. 2. http://freevideolectures.com/Course/2278/Data-Communication1

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-3: Introduction to Data Communication	Introduction to Data Communication, Network, Network types, The Physical layer: The Theoretical Basis for Data Communication, Guided Transmission Media, Wireless Transmission Section, Communication Satellites, The Public Switched Telephone Network, The Mobile Telephone System, Cable Television.
2	Week 4-6: Transmission Media	Introduction, Link-Layer addressing, Data link Control: DLC services, DataLink layer Protocols, Error detection and correction: Introduction, Block Coding.
3	Week 8-11: Data Link Layer	Random Access, Controlled Access. Wired LANs: Ethernet Protocol, Wireless LANs: Introduction, IEEE 802.11-Architecture, MAC Sub layer, Connecting devices and Virtual LANS.
4	Week 7-8: Network Layer and Internet Protocols	Network–Layer services, Packet Switching, IPV4 address Network layer Protocols: Internet Protocol.
5	Week 9-12: Transport Layer	Introduction, UDP, Transport-layer protocols, Transport-layer protocols: TCP services, TCP features, Segment, Application Layer: Introduction.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of OSl layers and data communication concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with realworld competencies.
5	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies

	Total of CIE and SEE (A+B+C)	**100 marks**

6	Laboratory Learning	Utilize the facilities available in the laboratories to understand the behavior of the materials by performing few experiments.

6. Assessment Details (both CIE and SEE)

Formative, Summative and other Assessments shall be conducted as per the Institution calendar of events in all the courses of the programme offered to the students, within the framework of Scheme of Teaching and Evaluation.

Assessments and Evaluation Process:

1) CIE and SEE constitute the major evaluations prescribed for each course, with only those students maintaining a minimum standard in CIE are permitted to appear in the SEE of the course.

2) CIE and SEE are to carry 50% weightage each, to enable the course to be evaluated for a total of 100 marks, irrespective of its credits.

3) The evaluation system of the programme is comprehensive and continuous during the entire period of the Semester, by the faculty who is teaching the course. For a course, the evaluation and grading will be on the following parameters:

A	**Continuous Internal Evaluation (CIE)**	**25 marks**
B	**Internal Assessment Tests (IAT)**	**25 marks**
Total of CIE (A+B)		**50 marks**
C	**Semester End Examination (SEE)**	**50 marks**

Continuous Internal Evaluation (CIE)

The minimum CIE marks requirement is 40% of the maximum marks in each component.

CIE Split up for Professional Course (PC)

Components		**Number**	**Weightage**	**Max. Marks**	**Min. Marks**
(i)	Internal Assessment-Tests (A)	**2**	50%	25	**10**
(ii)	Assignments/Quiz/Activity (B)	**2**	50%	25	**10**
Total Marks				**50**	**20**

Final CIE Marks = (A) + (B)

Average internal assessment shall be the average of the best two test marks from the 3 tests conducted.

Semester End Examinations

1. Question paper pattern will be ten questions. Each question is set for 20 marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks **7. Learning Objectives**

S/L	**Learning Objectives**	**Description**
1	Data Communication	Understanding in data communication will enable them to comprehend how these technologies interconnect and support modern communication systems. Describe the basic principles of data communication, including the various types of networks and their configurations. They will gain knowledge about different types of transmission media (both guided and wireless), communication satellites, and the infrastructure of public switched telephone networks, mobile telephone systems, and cable television.
2	Data Link Layer - Communication System	To learn basic methods for error detection and correction, including block coding, and apply these concepts to ensure reliable data transmission.
3	Medium Access Control- Communication System	Understand the fundamentals of wired and wireless LAN technologies, including Ethernet protocols, IEEE 802.11 architecture, MAC sub layer operations, connecting devices, and the concept of Virtual LANs (VLANs).

4	Network Layer Communication System	Describe the services provided by the network layer, understand packet switching, and explain the role of IPv4 addressing within network layer protocols, specifically focusing on the Internet Protocol (IP).
5	Transport Layer - Communication System	Explain the roles and features of transport-layer protocols, including UDP and TCP, and understand their functions in data transmission, as well as the basics of the application layer.
6	Simulation -Data Communication	Analyze and compare different network topologies, configure and evaluate Ethernet LANs, and assess packet loss in point-to-point networks.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC501.1	Explain the concepts of Computer Networks and Networks Models for Data Communication.
M23BEC501.2	Apply the knowledge of networking and concepts of TCP/IP protocol stack to deliver packets across Multiple Networks (links).
M23BEC501.3	Analyze the issues of routing and congestion mechanism for independent and internetworking networks for wired and wireless link.
M23BEC501.4	Design and apply subnet masks and routing addresses to fulfil networking requirements.
M23BEC501.5	Create Network for given specification using simulation tool (CISCO Packet tracker).

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC501.1	3	3	-	-	-	-	-	-	-	-	-	-	2	2
M23BEC501.2	3	3	-	-	-	-	-	-	-	-	-	-	3	2
M23BEC501.3	3	2	3	3	-	-	-	-	-	-	-	-	3	2
M23BEC501.4	3	3	-	3	-	-	-	-	-	-	-	-	3	3
M23BEC501.5	3	3	3	-	3	-	-	-	2	2	-	-	3	3
M23BEC501	**3**	**2.8**	**3**	**3**	**3**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**10**					**10**
Module 2			**10**			**10**
Module 3		**10**				**10**
Module 4		**5**	**5**			**10**
Module 5				**10**		**10**
Total	**10**	**15**	**15**	**10**		**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**

Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

10. Future with this Subject:

- Internet of Things (IoT) involves connecting everyday devices to the internet, enabling them to collect and exchange data. Knowledge of network models, digital transmission, and data link control is crucial for designing efficient and reliable IoT systems.
- 5G and Advanced Wireless Networks and to rollout of 5G technology relies heavily on advancements in wireless transmission and Medium Access Control protocols. Understanding bandwidth utilization and switching is essential for optimizing the performance of 5G networks.
- Cloud Computing and Virtualization and Cloud services depend on efficient data transmission and network management. Knowledge of network layers, IP addressing, and virtual LANs is key for designing scalable and secure cloud infrastructure.
- Cyber security, error detection, correction, and data link control that helps in securing data during transmission. Knowledge of network protocols and congestion control contributes to designing secure and resilient networks.
- Smart Grid and Energy Management utilizes data communication to monitor and manage electrical grids efficiently. Knowledge of network models, data link control, and Medium Access Control can aid in developing robust communication systems for real-time monitoring and control.

5TH Semester	**Integrated Professional Course (IPC) ARM CONTROLLER**	**M23BEC502**

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Electronics and Digital Logic	Familiarity with digital logic fundamentals, including binary numbers, logic gates, flip-flops, and state machines and requirements of basic electronics fundamentals
2	Microcontroller Fundamentals	Basic knowledge of microcontrollers and their architecture
3	Embedded C Programming	Strong skills in the C programming language, as it are the primary language used for programming ARM microcontrollers. Understanding of concepts like bitwise operations, memory management, pointers, and interrupts in the context of embedded systems
4	Development Tools and Environment	Experience with an IDE, which are commonly used for Microcontroller development. Understanding of tool chains, including compilers, assemblers, and linkers for Software.
5	Embedded System Concepts	Understanding of embedded systems design principles, Power management, realtime constraints, and the trade-offs between performance, power consumption, and cost.

2. Competencies

S/L	Competency	KSA Description
1	Thumb-2 Technology	**Knowledge:** understanding of ARM architecture, specifically the ARM CortexM3, Thumb-2 instruction set, including its mix of 16-bit and 32-bit instructions. **Skills:** ability to write and optimize code using the Thumb-2 instruction set in assembly language **Attitudes:** precise approach to writing and optimizing code, ensuring that Thumb-2 instructions are used effectively and appropriately

2	Assembly Language Basics	**Knowledge:** Understanding the fundamental syntax and structure of assembly language, Knowledge of key assembly language concepts, such as instructions, mnemonics, registers, labels, directives, and operands **Skills:** Ability to write clear, concise, and correct assembly language programs for the ARM Cortex-M3. **Attitudes:** Approach to writing and reviewing assembly code, as small errors can lead to significant issues in program execution.
3	Memory System Features	**Knowledge:** Understanding the overall memory architecture of the ARM Cortex- M3, including the types of memory and their characteristics **Skills:** Ability to configure and modify the memory map according to the needs of a specific application, optimizing memory usage for both code and data **Attitudes:** approach to understanding and working with memory systems, recognizing the critical impact of memory management on system stability and performance.
4	Exception Types and Priority	**Knowledge:** Comprehensive understanding of the different types of exceptions in ARM Cortex-M3, including reset, NMI (Non-Maskable Interrupt), hard fault, and other fault exceptions (e.g., memory management, bus fault, usage fault). **Skills:** Ability to configure and adjust exception priorities in the NVIC to ensure that critical exceptions are handled promptly. **Attitudes:** Approach to configuring exception priorities and writing exception handlers, recognizing that small mistakes can lead to significant system issues.
5	Developing with ARM Cortex-M3	**Knowledge:** Understanding of the typical development workflow for embedded systems, including system design, coding, compiling, linking, debugging, and testing **Skills:** Ability to write, compile, and debug C programs for ARM Cortex-M3 microcontrollers, optimizing code for performance and memory usage **Attitudes:** Approach to writing and reviewing code, understanding that even small errors can lead to significant issues in embedded systems.

3. Syllabus

ARM CONTROLLER SEMESTER – V			
Course Code	**M23BEC502**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**3:0:2:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory + 10 Lab slots**	Total Marks	**100**
Credits	**04**	Exam Hours	**03**

Course Objectives:

1. Describe the architectural features and instructions of 32-bit microcontroller ARM Cortex M3.
2. Apply the knowledge gained for Programming ARM Cortex M3 for different applications.
3. Apply he knowledge gained of ARM Cortex M3 in memory systems, exceptions and interrupt behavior
4. Demonstrate the Cortex M3 programming using C and assembly.

Module -1

ARM-32 bit Microcontroller: Thumb-2 technology and applications of ARM, Architecture of ARM Cortex M3, Various Units in the architecture, Debugging support, General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence

Module -2

ARM Cortex M3 Instruction Sets and Programming: Assembly basics, Instruction list and description, Thumb and ARM instructions, Special instructions, Useful instructions

Module -3

Memory Systems: Memory System Features Overview, Memory Maps, Memory Access Attributes, Default Memory Access Permissions, Bit-Band Operations, Unaligned Transfers

Cortex-M3 Implementation Overview: The Pipeline, A Detailed Block Diagram, Other Interfaces on the Cortex-M3, The External PPB, Typical Connections, Reset Types and Reset Signals

Module -4

Exceptions: Exception Types, Definitions of Priority, Vector Tables, Interrupt Inputs and Pending Behaviour.

Interrupt Behaviour: Interrupt/Exception Sequences, Exception Exits, Nested Interrupts, Tail-Chaining Interrupts, Late Arrivals, More on the Exception Return Value.

Module -5

Cortex-M3 Programming: Overview, A Typical Development Flow, CMSIS, Background of CMSIS, Area Standardization, Organization of CMSIS, Using CMSIS, Using Assembly, interface between assembly and C, First step in assembly level programming, producing outputs.

PRACTICAL COMPONENT

OF IPCC Conduct the following experiments by writing Assembly Language Program (ALP) using ARM Cortex M3 Registers using an evaluation board/simulator and the required software tool.

1	Write an ALP to generate Fibonacci series for 10 numbers
2	Write an ALP to add an array of 16-bit numbers and store the 32-bit result in internal RAM.
3	Write an ALP to find the largest/smallest number in an array of 32 numbers
4	Write an ALP to arrange a series of 32-bit numbers in ascending/descending order.
5	Write an ALP to count the number of ones and zeros in two consecutive memory locations
6	Write an ALP to count number of odd and even in an array.
7	Interface a simple Switch and display its status through Relay, Buzzer and LED.
8	Display the Hex digits 0 to F on a 7-segment LED interface, with a suitable delay in between
9	Interface a DAC and generate Triangular and Square waveforms.
10	Interface a Stepper motor and rotate it in clockwise and anti-clockwise direction.

11	Interface 4*4 keypad & display the Key Pressed on LCD or LED.
12	Toggle the LED when an external interrupt occurs.
13	**Open ended Project**: Display "Hello world" message using internal UART.

TEXTBOOKS:

1. Joseph Yiu, "The Definitive Guide to the ARM Cortex-M3", 2nd Edition, Newnes, (Elsevier), 2010.

REFERENCE BOOKS:

1. Andrew N Sloss, Dominic System and Chris Wright, "ARM System Developers Guide", Elsevier, Morgan Kaufman publisher, 1st Edition, 2008
2. Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, 2nd Edition.

VIDEO LINKS:

1.https://archive.nptel.ac.in/courses/106/105/106105193/

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: ARM 32 bit Microcontroller	Introduction to thumb technology, studying about the architecture of ARM M3 Microcontroller and knowing about general purpose registers, special registers, with exceptions and interrupts.
2	Week 3-5: Instruction set of programming	Studying about various instruction sets of 16 bit and 32 bit instructions of thumb and arm instructions dealing with special instructions and the useful instructions for ARM M3 Microcontroller
3	Week 6-8: Memory systems and implementation	Studying the memory system features, memory maps and memory access attributes with the pipelining of detailed block diagram with typical connections and reset sequences.
4	Week 9-10: Exceptions and interrupt behaviour	Studying about different exceptions, vector tables, interrupts, with exception sequences exceptions exits, nested interrupts and, tail chaining interrupts.
5	Week 10-12: Cortex M3 programming	Understanding about CMSIS, Studying about basics of programming using the c programming and Assembly language programming and the typical development flow.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of ARM M3 CORTEX architecture
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with real world competencies.
5	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
6	Laboratory Learning	Utilize the facilities available in the laboratories to understand the behavior of the programming by performing few experiments.

6. Assessment Details (both CIE and SEE) Continuous Internal Evaluation:

The minimum CIE marks requirement is 40% of maximum marks in each component. **CIE Split up**

A	Continuous Internal Evaluation (CIE)	**25 marks**
B	Internal Assessment Tests (IAT)	**25 marks**
Total of CIE (A+B)		**50 marks**
C	Semester End Examination (SEE)	**50 marks**
Total of CIE and SEE (A+B+C)		**100 marks**

CIE Split up for Integrated Professional Core Course (IPC)

Components		**Number**	**Weightage**	**Max. Marks**	**Min. Marks**
Theory(A)	Internal Assessment-Tests(A)	2	**60%**	**15**	**06**
	Assignments/Quiz/Activity(B)	2	**40%**	**10**	**04**
	Total Marks		**100%**	**25**	**10**
Components		**Number**	**Weightage**	**Max. Marks**	**Min. Marks**
Laboratory(B)	Record Writing Continuous	Continuous	**60%**	**15**	**06**
	Test at the end of the semester	1	**40%**	**10**	**04**
	Total Marks		**100%**	**25**	**10**

Final CIE Marks = (A) + (B) Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

1. Question paper pattern will be ten questions. Each question is set for 20 marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks.

7. Learning Objectives

S/L	**Learning Objectives**	**Description**
1	ARM 32 bit Microcontroller	Understanding of the ARM Cortex-M3 microcontroller's architecture, including its core components, pipeline, and operational flow. Learn the roles and functions of general-purpose registers, special registers, and the Program Counter
2	Instruction Set and Programming	Develop proficiency in programming the ARM Cortex-M3 using both assembly language and high-level languages like C. Learn the ARM and Thumb instruction sets, including special and useful instructions for embedded applications
3	Configuring the Memory System	Understanding of the Cortex-M3's memory system, including memory maps, access attributes, and bit-banding operations Learn how to configure memory access permissions, manage memory regions, and understand the implications of unaligned transfers..

4	Handling Exceptions and Interrupts	Understanding of the ARM Cortex-M3's exception handling mechanism, including the configuration and prioritization of exceptions and interrupts. Learn the different types of exceptions, including system exceptions, faults, and interrupt-driven exceptions
5	ARM Cortex-M3 in Real-World Applications	Learn how to design and implement embedded systems using ARM CortexM3, integrating hardware peripherals such as GPIO, timers, ADCs, and communication interfaces

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC502.1	**Present** the architectural features and instructions of 32 bit microcontroller ARM Cortex M3.
M23BEC502.2	**Apply** the knowledge gained for Programming ARM Cortex M3 for thumb and arm instructions.
M23BEC502.3	**Apply** ARM M3 features on memory systems, exceptions and interrupt behaviour.
M23BEC502.4	Analyze the behaviour of programming in C and assembly language in ARM cortex M3
M23BEC502.5	**Analyze** the outcomes of the simulated of the assembly language program.
M23BEC502.6	**Conduct** experiments either individually or in a team and **present** the corresponding outcomes and process both orally and in a written form.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC502.1	2	-	-	-	-	-	-	-	-	-	-	-		-
M23BEC502.2	-	3	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC502.3	-	3	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC502.4	-	-	3	-	-	-	-	-	-	-	-	-	3	-
M23BEC502.5	-	-	3	-	-	-	-	-	-	-	-	-	3	-
M23BEC502.6	-	-	-	-	3	-	-	-	3	-	-	-	-	-
M23BEC502	2	3	3		3	-	-	-	3	-	-	-	3	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	CO6	Total
Module 1	**5**				**10**	**10**	**10**
Module 2		**5**					**10**
Module 3			**5**				**10**
Module 4				**5**			**10**
Module 5				**5**			**10**
Total	**5**	**5**	**5**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	CO6	Total
Module 1	**20**						**20**
Module 2		**20**					**20**
Module 3			**20**				**20**
Module 4				**20**			**20**
Module 5				**20**			**20**
Total	**20**	**20**	**20**	**40**			**100**

10. Future with this Subject:

- **Increased Adoption in IoT and Embedded Systems**: ARM controllers are becoming the standard for IoT (Internet of Things) devices due to their low power consumption, high performance, and scalability. This trend is likely to continue as more devices become interconnected
- **Advancements in AI and Machine Learning**: ARM controllers are increasingly being integrated with AI and machine learning capabilities. This allows for on-device processing of data, reducing latency and improving the efficiency of smart devices. Future ARM processors are expected to have even more specialized hardware for AI tasks
- **Expansion in Edge Computing**: With the rise of edge computing, ARM controllers are playing a critical role in processing data closer to where it is generated. This trend will likely accelerate as edge devices become more powerful and autonomous, reducing the need to send data to centralized cloud servers.
- **Sustainability and Energy Efficiency**: Energy efficiency becomes more important; ARM controllers are well-positioned due to their power-efficient architecture. Future developments may focus even more on reducing energy consumption, particularly in battery-operated devices and largescale data centers.
- **5G Integration**: The deployment of 5G networks will enhance the capabilities of ARM controllers, particularly in areas like real-time data processing, autonomous vehicles, and smart cities. ARM controllers will likely be integral in devices that need to handle the high speeds and low latency of 5G.

5th Semester	Professional Course (PC) DIGITAL COMMUNICATION	M23BEC503

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Mathematics and Algebra	Understanding of algebra, calculus, and probability/statistics is crucial. Concepts such as signal processing, Fourier transforms, and probability distributions are often used in digital communication.
2	Fundamentals of Electronics	Knowledge of basic electronics and circuits is important, as digital communication often involves the design and analysis of electronic systems.
3	Linear Systems and Signals	Familiarity with linear systems, signal processing, and analysis is essential. Concepts like Fourier series, Laplace transforms and discrete signals & systems are fundamental.
4	Computer Science Basics	Understanding computer science principles, particularly in programming and algorithms is beneficial. Many aspects of digital communication involve data encoding, error correction and network protocols.
5	Communication Theory	Basic knowledge of communication theory, including concepts like modulation, demodulation, and noise, is useful. Understanding analog communication principles can also provide a helpful context.
6	Software Tools	Familiarity with software tools used for simulations and analysis, like MATLAB or Python, can be advantageous for practical applications and experimentation.

2. Competencies

S/L	Competency	KSA Description
1	Understanding of basic concepts of digital communication systems	**Knowledge:** Model of digital communication system with its advantages and limitations over analog systems, information and entropy of a signal along with sampling. **Skills:** Able to apply the basic concepts to understand the various processes in depth. **Attitudes:** Appreciates the advantages of digital communication.
2	Information on waveform coding techniques	**Knowledge:** Concepts of various quantizer types and techniques such as PCM and DM. **Skills:** Able to analyse and compare various coding techniques. **Attitudes:** Appreciate optimisation of the parameters as per the application.
3	Understanding on digital Baseband Transmission	**Knowledge:** Line coding and its properties for uni polar, polar, bipolar, AMI & Manchester coding, Base band Transmission of digital signals: Inter-symbol Interference, Eye Pattern, Nyquist criterion for distortionless Transmission **Skills:** Analyzing line coding types with respect to parameters such as DC level, timing information, transmitter power etc. Design concepts to avoid ISI **Attitudes:** Analytical attitude towards selecting reliable communication systems and accurately assessing signal integrity and error rates.
4	Awareness on digital Band pass Transmission & Reception	**Knowledge:** Process of generation and detection of ASK, FSK, PSK , DPSK and QPSK and their comparative study. **Skills:** Equipped with ability in selecting the most effective modulation techniques for various communication scenarios. **Attitudes:** Analytical attitude towards evaluating and choosing appropriate modulation methods based on performance criteria and application needs.

5	Acquaintance with Spread spectrum Techniques	**Knowledge:** Information on Spread spectrum Techniques, PN sequence , Applications **Skills:** Analysing Spread spectrum techniques and choosing the optimum type. **Attitudes:** Attention to details of Spread spectrum techniques so as to select appropriate method for an application.

3. Syllabus

DIGITAL COMMUNICATION SEMESTER – V			
Course Code	**M23BEC503**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**4:0:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**50 hours Theory**	Total Marks	**100**
Credits	**04**	Exam Hours	**03**

Course Objectives:

1. To understand the fundamental concepts of digital communication.
2. To understand various waveform coding techniques in digital communication systems.
3. To evaluate the performance of various digital modulation systems.
4. To analyze performance issues in recovery of signals in ideal and corrupted channel conditions.
5. To design and interface communication systems for a given application.

Module -1

Introduction: Digital communication system model, modulation process, analog vs. digital communication; Limitations of communication systems, Entropy, Source coding theorem, Discrete memory-less channel, channel capacity, channel coding theorem, Sampling process.

Module -2

Waveform Coding Techniques: Discretization in time and amplitude. Linear quantizer, quantization noise power calculation, signal to quantization noise ratio, non – uniform quantizer, A law & μ law companding encoding and pulse code modulation, bandwidth of PCM, Delta modulation.

Module -3

Digital Baseband Transmission: Line coding and its properties. NRZ & RZ types, signalling format for uni polar, polar, bipolar, AMI & Manchester coding. Baseband Transmission of Digital signals: Introduction, Intersymbol Interference, Eye Pattern, Nyquist criterion for distortion less Transmission.

Module -4

Digital Band pass Transmission & Reception: Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), QPSK Bandwidth Efficiency.
Optimum receivers using coherent detection, Correlation receiver, Matched filter receiver, probability of error, Power spectral density, PSK–coherent detection, Generation and detection of QPSK, Generation and detection of coherent FSK, Binary FSK using non-coherent detection, Differential Phase Shift Keying: Generation and detection.

Module -5

Spread Spectrum Modulation: Model of a Spread Spectrum System, Direct Sequence Spread Spectrum Systems, Effect of De-spreading on a narrowband Interference, Probability of error (statement only), Generation and properties of PN Sequences and Frequency Hopped Spread Spectrum system.
Applications of DS Spread Spectrum Signals: CDMA, Muti path suppression, Range detection using DS spread spectrum.

TEXTBOOKS:

1. Simon Haykin, Michael Moher "Communication Systems", John Wiley & sons, Fifth Edition, ISBN-13: 978-0-471-69790-9
2. John G Proakis and Masoud Salehi, "Fundamentals of Communication Systems", 2018 Edition, Pearson Education, ISBN 978-8-131-70573-5.

REFERENCE BOOKS:

1. B.P. Lathi and Zhi Ding, "Modern Digital and Analog Communication Systems", Oxford University Press, 4th Edition, 2010, ISBN: 978-0-198-07380-2.
2. Digital communications, 3rd Edition, K N Hari Bhat, D. Ganesh Rao Video Links:
1. https://onlinecourses.nptel.ac.in/

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Introduction	Digital communication system model, modulation process, analog vs. digital communication; limitations of communication systems, Information and Entropy along with Sampling process.
2	Week 3-5: Waveform Coding Techniques	Understanding the concepts of Linear quantizer, quantization noise power calculation, signal to quantization noise ratio, non – uniform quantizer, encoding and pulse code modulation, bandwidth of PCM and Delta modulation.
3	Week 6-8: Digital Modulation Schemes	Process of generation and detection of ASK, FSK, BPSK, DPSK, QPSK and their comparative study.
4	Week 9-10: Digital Baseband Transmission	Line coding types and their properties for uni-polar, polar, bipolar, AMI & Manchester coding. Baseband Transmission of Digital signals: Introduction, Intersymbol Interference, Eye Pattern, Nyquist criterion for distortion less Transmission
5	Week 11-12: Performance Analysis-Detection	Also, Model of a Spread Spectrum System, Direct Sequence Spread Spectrum Systems, some applications of DS Spread Spectrum Signals, Generation of PN Sequences, Frequency Hopped Spread Spectrum..

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with realworld competencies.

6. Assessment Details (both CIE and SEE)

A	**Continuous Internal Evaluation (CIE)**	**25 marks**
B	**Internal Assessment Tests (IAT)**	**25 marks**
	Total of CIE (A+B)	**50 marks**
C	**Semester End Examination (SEE)**	**50 marks**

Total of CIE and SEE (A+B+C)	100 marks

CIE Split up for Professional Course (PC)

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	**2**	50%	25	**10**
(ii)	Assignments/Quiz/Activity (B)	**2**	50%	25	**10**
Total Marks				**50**	**20**

Final CIE Marks = (A) + (B)

Average internal assessment shall be the average of the best two test marks from the 3 tests conducted.

Semester End Examinations

1. Question paper pattern will be ten questions. Each question is set for 20 marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding basic concepts of digital communication.	Learning Model, advantages and limitations of digital communication system concerning analog systems and sampling process.
2	Apply concepts of information theory to digital Communication.	Utilize Entropy, Information rate, DMC along with Sampling methods with respect to digital communication.
3	Analyzing Waveform coding techniques	Analyze concepts of various quantizer types and techniques such as PCM and DM.
4	Analyzing types of digital modulation techniques	Examine the process of ASK, FSK, BPSK, QPSK and their comparative study along with types of spread spectrum modulation systems.

5	Analyze issues in base band transmission.	Analyze performance issues and parameters for symbol processing and recovery in ideal and corrupted channel conditions.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC503.1	**Illustrate** the concepts of digital communication systems and spread spectrum techniques.
M23BEC503.2	**Apply** the basics of waveform coding techniques to digital communication and concepts of ISI to band limited channels.
M23BEC503.3	**Analyze** properties of line coding techniques.
M23BEC503.4	**Analyze** different digital modulation / detection schemes.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC503.1	3	3	-	-	-	-	-	-	-	-	-	-	2	2
M23BEC503.2	3	3	2	-	-	-	-	-	-	-	-	-	2	2
M23BEC503.3	3	3	2	-	-	-	-	-	-	-	-	-	2	2
M23BEC503.4	3	3	2	-	-	-	-	-	-	-	-	-	2	2
M23BEC503	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	Total
Module 1	**10**				**10**
Module 2		**10**			**10**
Module 3			**10**		**10**
Module 4				**15**	**15**
Module 5	**5**				**5**
Total	**15**	**10**	**10**	**15**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	Total
Module 1	**20**				**20**
Module 2		**20**			**20**
Module 3			**20**		**20**
Module 4				**30**	**30**
Module 5	**10**				**10**
Total	**30**	**20**	**20**	**30**	**100**

10. Future with this Subject:

The future scope of learning digital communication techniques encompasses various trends and developments that are shaping the field. Here are some key points highlighting the future potential and significance:

- Integration of AI and Automation: AI and automation are transforming digital communication by enabling more personalized and efficient interactions. Mastering tools and techniques related to chatbots, automated responses, and content generation will be essential for staying competitive.

- Advancements in Social Media: Social media platforms are continually evolving with new features and algorithms. Staying updated with these changes and learning how to effectively use emerging tools and platforms will be important for maximizing reach and engagement.
- Emergence of New Communication Channels: New digital channels and technologies, such as virtual reality (VR), augmented reality (AR), and immersive experiences, are becoming more prevalent. Learning how to create and manage content for these channels will be key to staying at the forefront of digital communication.
- Emphasis on Ethical Communication: With growing concerns about privacy, misinformation, and ethical practices, there will be a heightened focus on responsible and transparent communication. Developing skills in ethical communication and understanding regulatory guidelines will be important for maintaining credibility and integrity in digital interactions.

These points reflect the dynamic and evolving nature of digital communication, highlighting the need for continuous learning and adaptation in this field.

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Fundamentals of Electronics	• A solid understanding of basic electronics principles, including circuit theory, semiconductor devices, and signal processing, is essential. This foundation helps students grasp the more complex concepts and components used in advanced communication systems.
2	Analog and Digital Communication theory	• Familiarity with both analog and digital communication techniques, such as modulation, demodulation, and encoding/decoding, is crucial. This includes understanding concepts like AM, FM, PM, and digital modulation schemes..
3	Mathematical Skills	• Strong skills in mathematics, particularly in areas such as Fourier transforms, Laplace transforms, probability theory, and linear algebra, are important. These mathematical tools are frequently used to analyze and design communication systems and processes.
4	Experience with Communication Equipment and Tools	• Practical experience with communication hardware and software tools, such as oscilloscopes, signal generators, spectrum analyzers, and network analyzers, is valuable. Knowing how to operate and interpret data from these instruments is essential for hands-on lab work.
5	Basic Programming Knowledge	• Proficiency in programming languages and tools, such as MATLAB, Python, or LabVIEW, is often required. These skills are useful for simulations, data analysis, and automation of experiments, which are common in advanced communication labs..

2. Competencies

S/L	Competency	KSA Description
1.	Designing ASK, FSK circuits using Transistors	**Knowledge:** Knowledge of designing transistor circuits for generation of ASK and FSK modulated signals. **Skills:** Ability to apply the concepts of ASK and FSK modulation to design the required analog circuit. Proficiency in analyzing the circuits used for generation of ASK and FSK signals. **Attitudes:** Appreciation for designing simple circuits for ASK and FSK using transistors and analysing the parameters.

2.	Analyzing PSK and QPSK modulation	**Knowledge:** Understanding the process of PSK and QPSK schemes. **Skills:** Demonstrating the operation of PSK and QPSK modulation using KIT/ Simulation. **Attitudes:** Appreciation for the ability to analyze PSK and QPSK signals.
3.	Acquaintance with Microwave test bench measurements	**Knowledge:** Understanding Measurement of frequency, guide wavelength, power, VSWR and attenuation in microwave test bench. **Skills:** Able to generate microwave signal using Klistron Tube. **Attitudes:** Appreciate the ability to measure the parameters of microwave signal..
4.	Awareness about measurement of directivity and gain of antennas	**Knowledge:** Understanding the se up of Measurement of directivity and gain of microstrip dipole and Yagi antennas. **Skills:** Analyzing the radiation patterns of the antennas. Evaluating the gain and half power bandwidth. **Attitudes:** Appreciation for the role of antenna in communication systems.
5	Acquaintance with Micro-strip ring resonator / coupler experiments	**Knowledge:** Understanding the Resonance characteristics of microstrip ring resonator. Coupling and isolation characteristics of microstrip directional coupler. **Skills:** Computation of dielectric constant of the substrate / coupling factor **Attitudes:** Valuing the importance ring resonator/ couplers in microwave systems.
6.	Awareness about PCM / TDM techniques	**Knowledge:** Understanding the concepts of Pulse Code Modulation and TDM **Skills:** Able to analyse waveforms at various points of the circuit. **Attitudes:** Valuing the importance TCM in communication systems**.**

3. Syllabus

DIGITAL COMMUNICATION LABORATORY SEMESTER - V			
Course Code	**M23BECL504**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**0:0:2:0**	SEE Marks	**50**
Total Number of Lecture Hours	**12**	Total Marks	**100**
Credits	**01**	Exam Hours	**03**

Course objectives: This course will enable students to:

- · Design and demonstrate the digital modulation techniques
- ·Demonstrate and measure the wave propagation in microstrip antennas
- ·Demonstrate characteristics of microstrip devices and measurement of its parameters.
- Analyzing PCM/ TDM systems
- Understanding Measurement of frequency, guide wavelength, power, VSWR and attenuation in microwave test bench.

PRACTICAL COMPONENT

Sl. No.	**Experiments**
1	ASK generation and detection (discrete components)
2	FSK generation and detection (discrete components)

3	PSK generation and detection
4	Measurement of frequency, guide wavelength, power, VSWR and attenuation using microwave test bench.
5	Measurement of directivity and gain of microstrip dipole and Yagi antennas.
6	Coupling and isolation characteristics of microstrip directional coupler.
7	Resonance characteristics of microstrip ring resonator and computation of dielectric constant of the substrate
8	PCM coder
9	Time Division Multiplexing and De multiplexing of two band limited signals.
10	DPSK generation and detection(Simulation)
11	QPSK generation and detection (Simulation)
12	EYE pattern generation (Simulation)
13	Open Ended Experiment: Generation and detection of PCM , Delta modulation using MATLAB/ Simulink/ LAB View

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1	LAB Introduction
2	Week 2	Batch A- ASK generation and detection (discrete components) Batch B-Coupling and isolation characteristics of microstrip directional coupler and characteristics of Ring Resonator
3	Week 3	Batch A-FSK generation and detection (discrete components) Batch B- Measurement of directivity and gain of microstrip dipole and Yagi antennas.
4	Week 4	Batch A PSK generation and detection Batch B PCM coder
5	Week 5	Batch A DPSK Simulation Batch B-TDM coder
6	Week 6	Batch A QPSK Simulation Batch B EYE pattern Simulation
7	Week 7-12:	Note: Batches will be swapped and will carry-out the corresponding Experiments.
8	Week 13	Measurement of frequency, guide wavelength, power, VSWR and attenuation in microwave test bench
9	Week 14	LAB test

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Experiment-Based Learning (EBL)	Implement EBL to enhance analytical skills and practical application of competencies
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.

6. Assessment Details (both CIE and SEE)

- CIE marks for a practical course shall be 50 marks.

- The split up of CIE marks for record / journal and test to be split in the ratio 60:40.
- Record write up for individual experiment will be evaluated for 10 Marks.
- Total marks scored for record writing and conduction shall be scaled downed to 30 marks (60% of maximum marks).
- One test for100 marks after the completion of the experiments at the end of the semester.

Test Marks distribution for Experiment based Practical Course for CIE

Sl. No.	Description	% of Marks	In Marks
1	Write-up, Conduction, result and Procedure	60%	60
2	Viva-Voce	40%	40
Total		**100%**	**100**

The Test marks should be scaled down to 20 marks (40% of the **maximum CIE Lab Marks (50)) Final CIE in Practical Course:**

Marks distribution for Experiment based Practical Course for Final CIE

Sl. No.	Description	% of Marks	In Marks
1	Scaled Down marks of record / journal	60% of the maximum	30
2	Scaled Down marks of test	40% of the maximum	20
Total		**100%**	**50**

SEE for practical Course:

1. SEE marks for practical course shall be 50marks.

Marks distribution for Experiment based Practical Course for Final CIE

SL. No.	Description	% of Marks	Marks
1	Write-up, Procedure	20%	20
2	Conduction and result	60%	60
3	Viva-Voce	20%	20
Total		**100%**	**100**

2. SEE for practical course is evaluated for 100 marks and scored marks shall be scaled down to 50 marks.
3. Change of experiment/program is allowed only once and 20% marks allotted to the procedure/write-up part to be made zero.
4. Duration of SEE shall be 3 hours.

7. Learning Objectives

S/L	Learning Objectives	Description
1	Digital modulation techniques	Design/ demonstrate/ simulate the digital modulation techniques.
2	Microwave generation and measurements	Understanding Measurement of frequency, guide wavelength, power, VSWR and attenuation in microwave
		test bench
3	Microwave Transmission and reception	Demonstrate and measure the wave propagation and draw the radiation pattern in microstrip antennas
4	Microwave couplers/ Resonator	Characteristics of microstrip devices and measurement of its parameters
5	PCM/ TDM systems	Analysing PCM/ TDM systems
6	Simulation of EYE pattern	Analysing the concepts of EYE pattern.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BECL504.1	Demonstrate / Conduct/ Simulate digital communication / Microwave Experiment

M23BECL504.2	Test / Measure / Draw the parameters / waveforms.
M23BECL504.3	Analyze the parameters as per the experiment.
M23BECL504.4	Present / Document the experimental process and corresponding outcomes in written / oral form either individually/team.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BECL504.1	3	2	-	-	3	-	-	-	2	3	-	-	3	3
M23BECL504.2	3	2	-	-	3	-	-	-	2	3	-	-	3	3
M23BECL504.3	3	2	-	-	3	-	-	-	2	3	-	-	3	3
M23BECL504.4	3	2	-	-	3				2	3		-	3	3
M23BECL504	**3**	**3**	**-**	**-**	**3**	**-**	**-**	**-**	**2**	**3**	**-**	**-**	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	Total
Experiment 1	10	10	10	20	50
Experiment 2	10	10	10	20	50
Experiment 3	10	10	10	20	50
Experiment 4	10	10	10	20	50
Experiment 5	10	10	10	20	50
Experiment 6	10	10	10	20	50
Experiment 7	10	10	10	20	50
Experiment 8	10	10	10	20	50
Experiment 9	10	10	10	20	50
Experiment 10	10	10	10	20	50
Experiment 11	10	10	10	20	50
Experiment 12	10	10	10	20	50

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	Total
Experiment	**10**	**10**	**10**	**20**	**50**

Conditions for SEE Paper Setting:

Each module of SEE question paper should be allocated with questions for 20% of the total SEE marks

10. Future with this Subject

The future scope of learning digital communication techniques encompasses various trends and developments that are shaping the field. Here are some key points highlighting the future potential and Significance:

- **Integration of AI and Automation**: AI and automation are transforming digital communication by enabling more personalized and efficient interactions. Mastering tools and techniques related to chatbots, automated responses, and content generation will be essential for staying competitive.
- **Emergence of New Communication Channels**: New digital channels and technologies, such as virtual reality (VR), augmented reality (AR), and immersive experiences, are becoming more prevalent. Learning. How to create and manage content for these channels will be key to staying at the forefront of digital communication.
- **Increased Focus on Cyber security**: As digital communication involves sensitive information, understanding cyber security principles and best practices will be increasingly important. Protecting data and ensuring secure communication will be critical for maintaining trust and compliance.
- **Emphasis on Ethical Communication**: With growing concerns about privacy, misinformation, and ethical practices, there will be a heightened focus on responsible and transparent communication. Developing skills in ethical communication and understanding regulatory guidelines will be important for maintaining credibility and integrity in digital interactions.

5th Semester	**Professional Elective Course (PE-I) INFORMATION THEORYAND CODING**	**M23BEC505A**

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Understanding of Signals	• Understanding digital signals and their processing is helpful for communication systems. • To understand the conversion process of an analog signal to digital signal.
2	Communication Systems:	• Basic knowledge of communication systems can provide context for the application of Information Theory concepts. • Basic blocks involved in conversion of message signal to binary bits of zeroes and ones.
3	Probability Theory:	• Forms the backbone of Information Theory, as it deals with uncertainty and randomness in communication. • Different definitions such as joint, conditional, symmetric properties.
4	Linear Algebra:	• Essential for coding theory, where algebraic structures are used to construct error-correcting codes. • Different types of codes such as Linear block codes, cyclic codes, and convolutional codes.
5	Discrete Mathematics:	• Provides the foundation for combinatorial aspects of coding theory and information theory. • Discrete Mathematics covers some important concepts such as set theory, graph theory, logic, permutation and combination.

2. Competencies

S/L	Competency	KSA Description
1	Measure of Information	**Knowledge:** Understanding of entropy, redundancy, and data compression limits as defined by Shannon's theorem. **Skills:** Ability to apply probabilistic models to predict data patterns and optimize compression. **Attitudes:** Commitment to ensuring the integrity and accuracy of the compressed data.
2	Types of Coding	**Knowledge:** Knowledge of fundamental theorems such as Kraft-McMillan inequality and Shannon's source coding theorem. **Skills:** Ability to analyze the efficiency of compression algorithms in terms of compression ratio, speed, and computational complexity. **Attitudes:** Persistence in optimizing algorithms and solving complex problems related to data compression.
3	Types of Channels	**Knowledge:** Understanding the capacity of a channel to convey information, Knowledge of which channel is most effective for different types of communication. **Skills:** Ability to select the most appropriate channel for a given message based on factors like urgency, complexity, and audience preference. **Attitudes:** Commitment to learning about new communication channels and techniques to continuously improve communication effectiveness.

4	Types of Error Control Coding	**Knowledge:** Understanding basic principles such as parity checks, cyclic redundancy checks (CRC), and error-correcting codes (ECC). Awareness of the fundamental limits of error correction and the capacity of communication channels. Knowledge of matrices, vectors, and linear transformations used in coding theory. **Skills:** Awareness of the fundamental limits of error correction and the capacity of communication channels. Ability to implement error control algorithms using programming languages such as Python, C++, or MATLAB.

		Attitudes: Precision in developing and applying error control techniques to ensure high data integrity.
5	Types of Convolutional Codes	**Knowledge:** Knowledge of the Viterbi algorithm, trellis diagrams and state diagrams used in the analysis and design of convolution codes. Knowledge of finite state machines (FSMs) and how they model convolution encoders and decoders. **Skills:** Ability to implement convolution encoding and decoding algorithms using programming languages such as Python, C++, or MATLAB. **Attitudes:** Willingness to explore new techniques and improvements in convolutional coding to address emerging challenges and enhance performance.

3. Syllabus

INFORMATION THEORY AND CODING SEMESTER – V			
Course Code	**M23BEC505A**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**3:0:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course Objectives:

1. To Understand the concept of entropy, the rate of information concerning dependent and independent sources.
2. To Study various source encoding algorithms.
3. To Model discrete communication channels.
4. To Study various error-controlling algorithms.

Module -1

Introduction to Information Theory: Measure of information, the Information content of a message, Average information content of symbols in long independent sequences, Mark statistical model for information source, Entropy and information rate of mark- off sources. Average information content of symbols in long dependent sequences.

Module -2

Source Encoding: Encoding of the source output, Shannon's encoding algorithm. Shannon's Fano encoding algorithm, Huffman codes, Extended Huffman coding, Arithmetic coding, Lempel-Ziv Algorithm.

Module -3

Communication channels: Channel matrix, joint probability matrix, system entropies, mutual information, channel capacity, channel capacity of: Symmetric channel, Binary Symmetric Channel, Binary Erasure Channel, Muroga's Theorem.

Module -4

Error control coding: Introduction, Examples of Error control coding, methods of controlling errors, types of errors, types of codes, Linear Block Codes: matrix description of linear block codes, error detection and error correction capabilities of linear block codes, single error correcting hamming codes.
Binary Cyclic Codes: Algebraic structure of cyclic codes, encoding using an (n- k) bit shift register, syndrome calculation, error detection and correction. Table lookup decoding using standard array.

Module -5

Convolution codes: encoders, time domain approach, transform domain approach, Code tree, Trellis and State diagram, the Viterbi algorithm.

TEXTBOOKS:

1. K. Sam Shanmugam, "Digital and Analog Communication systems", John Wiley India Pvt Ltd, 2006.
2. Simon Haykin, "Digital Communication", John Wiley India Pvt Ltd, 2008.

REFERENCE BOOKS:

1. Ranjan Bose, "ITC and Cryptography", TMH, II edition, 2007.
2. J. Das, S. K .Mullick, P.K. Chatterjee, "Principles of digital communication", Wiley, 1998.
3. BernardSklar, Second Edition, "Digital Communications-Fundamentals and Applications", Pearson Education,2016
4. K.N.HariBhat, D.GaneshRao, "Information Theory and Coding", Cengage Learning 2017.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-3: Information Theory	Introduction to digital communication system. Measure of information, Information content of message, Average information content of symbols in long independent sequences, Mark off statistical model for information source, Entropy and information rate of mark- off sources.
2	Week 4-6: Source Coding	Understanding the concepts Encoding of the source output, Shannon's encoding algorithm. Shannon's Fano encoding algorithm, Huffman codes, Extended Huffman coding.
3	Week 8-11: Information Channels	Studying the different types Communication channels. Channel matrix, joint probability matrix, system entropies, mutual information, channel capacity, channel capacity of: Symmetric channel, Binary Symmetric Channel.
4	Week 7-8: Error Control Coding	Analyzing the Examples of Error control coding, methods of controlling errors, types of errors, types of codes, Linear Block Codes: matrix description of linear block codes, error detection and error correction capabilities of linear block codes, single error correcting hamming codes.
5	Week 9-12: Convolution codes	Introduction to Convolution encoders, time domain approach, transform domain approach, Code tree, Trellis and State diagram, the Viterbi algorithm.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of Information and theory coding concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with real world competencies.
5	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
6	Laboratory Learning	Utilize the facilities available in the laboratories to understand the behavior of the materials by performing few experiments.

6. Assessment Details (both CIE and SEE) Continuous Internal Evaluation:

The minimum CIE marks requirement is 40% of maximum marks in each component. **CIE Split up**

Components		Number	Weight age	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks =A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

1. Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Information Theory	Grasp the basic principles of probability theory, Average information content of symbols in long independent sequences, Mark off statistical model for information source, Entropy and information rate of mark- off sources.
2	Source Coding	Understanding the concepts Encoding of the source output, Shannon's encoding algorithm. Shannon's Fano encoding algorithm, Huffman codes, Extended Huffman coding.
3	Information Channels	Analyze different types Communication channels such as Channel matrix, joint probability matrix, system entropies, mutual information, channel capacity, channel capacity of: Symmetric channel, Binary Symmetric Channel.
4	Error Control Coding	Analyzing the Examples of Error control coding, methods of controlling errors, types of errors. Linear Block Codes: matrix description of linear block codes, error detection and error correction capabilities of Linear block codes, single error correcting hamming codes.
5	Binary Cyclic Codes	Understand the Algebraic structure of cyclic codes, encoding using an (n- k) bit shift register, syndrome calculation, error detection and correction.
6	Convolution codes	To analyzeConvolution encoders, time domain approach, transform domain approach, Code tree, Trellis and State diagram, the Viterbi algorithm.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC505A.1	**Present** the comprehension of the concepts; measure of information, entropy, dependent sources, communication channels and different coding techniques in information theory.
M23BEC505A.2	**Apply** the concepts of entropy to solve related problems and various source encoding techniques to represent the information.
M23BEC505A.3	**Model** the continuous and discrete communication channels using input, output and joint probabilities

M23BEC505A.4	**Apply** error control and convolution coding techniques to determine a code word comprising of check bits.
M23BEC505A.5	**Design** the encoding and decoding circuits for Linear Block codes, cyclic codes, and convolutional codes

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC505A.1	3	-	-	-	-	-	-	-	-	2	-	-	-	-
M23BEC505A.2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC505A.3	3	2	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC505A.4	3	2	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC505A.5	2	2	2	-	-	-	-	-	-	-	-	-	2	-
M23BEC505	**2.75**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**2.75**	**-**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**

Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

10. Future with this Subject:

- Quantum Information Theory: In Quantum Communication for developing quantum error correction codes to enable secure and high-speed quantum communication. Quantum Cryptography for exploring quantum key distribution for unbreakable encryption.
- Data Compression and Storage: Lossless and Lossy Compression for Developing advanced algorithms for image, video, and audio compression. DNA Storage Exploring information storage in biological systems. Data Recovery in developing techniques for recovering data from corrupted or damaged.
- Privacy and Security: Differential Privacy Developing techniques to protect sensitive data while enabling useful computations. Secure Communication for Designing robust encryption and authentication schemes.
- Machine Learning and Information Theory: Applying information theory to understand and improve feature representations. Generative Models Using information-theoretic principles to develop better generative models. Reinforcement Learning combining information theory with reinforcement learning for optimal decision-making.
- Biology and Information Theory: Applying information theory to analyze biological data and understand genetic information. Neuroscience for investigating information processing in the brain.

5th Semester	Professional Elective Course (PE-I)	M23BEC505B

NANOTECHNOLOGY

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Physics:	Basic knowledge of different materials and their behaviors under various medium conditions. Fundamental concepts of classical mechanics, electromagnetism, and quantum mechanics basics. Understanding solid-state physics, and thermodynamics.
2	Mathematics:	Understanding of solving linear and quadratic equations Proficiency in differential and integral calculus, including applications.
3	Communication Basics:	Grasp of communication principles such as transmission and reception, modulation techniques. Bandwidth and data rate optimizations, noise, and signal integrity. Multiplexing, channel capacity, error detection, and correction.
4	Material Science:	Understanding the material properties atomic and molecular structure, crystallography Basic concepts of stress, strain, and material properties and their characterization techniques. Material Synthesis and Fabrication Techniques, nanofabrication Methods.
5	Spintronics:	Basics of Magnetic Resonance like Nuclear Magnetic Resonance (NMR) and Electron Spin Resonance (ESR) to study the magnetic properties of nano materials. Understanding how spin waves propagate in magnetic nanostructures, which aims to use electron spin rather than charge for information processing.
6	Electro Magnetic (EM) waves:	Understanding how light can travel within material, Light-Matter Interaction, Photon Interaction with Nanomaterials. Concept of EM wave properties related to EMI Electromagnetic Field Manipulation like Near-Field and Far-Field Effects Ability to use Maxwell's equations, which are fundamental for modelingand simulating the electromagnetic behavior of nanoscale systems.

2. Competencies

S/L	Competency	KSA Description
1	Introduction	**Knowledge:** Basic principles of atoms, molecules, forces, energy, waves, quantum mechanics, atomic structure, chemical bonding, and reactions. **Skills:** Ability to apply basic scientific concepts and principles to understand the behavior of materials at the nanoscale. **Attitudes**: Curiosity, enthusiasm for innovation, attention to detail, perseverance, ethical awareness, and collaboration.

2	Characterization	**Knowledge:** Concepts of different types of microscopy, spectroscopy, and diffraction techniques to Understand nano materials' structure, properties, and behavior, including nanoparticles, nanowires, nanotubes, quantum dots, and thin films. **Skills:** Ability to prepare nanomaterials for characterization, including handling delicate samples, coating, sectioning, and ensuring that samples are representative and contaminant-free. **Attitudes:** Attention to detail in measurements and analysis to accurately diagnose small errors in characterization that can lead to significant misinterpretations.
3	Fabrication techniques	**Knowledge:** Understand the techniques like photolithography, electron-beam lithography, and ion-beam milling, which involve carving out nanostructures from larger materials. **Skills:**
		Ability to optimize fabrication processes to achieve desired nanostructure properties, including controlling parameters such as temperature, pressure, and deposition rates. **Attitudes:** Attention to detail to invest time in perfecting fabrication techniques, understanding that nanofabrication can be a complex and iterative process requiring persistence.
4	Carbon Nanotubes	**Knowledge:** Understand the atomic structure of carbon nanotubes, including the distinction between single-walled carbon nanotubes (SWCNTs) and multiwalled carbon nanotubes (MWCNTs). **Skills:** Ability to be proficient in synthesizing CNTs using techniques like CVD, and understanding how to control growth conditions to produce CNTs with desired properties. **Attitudes:** Precision in conducting experiments, characterizing materials, and analyzing data, recognizing that small variations can significantly impact CNT properties and performance.
5	Nanosensors	**Knowledge:** Understand the basicprinciples of sensors, including transduction mechanisms (e.g., electrical, optical, mechanical), and how these principles are applied at the nanoscale. **Skills:** Ability to design nanosensors tailored to specific applications, including selecting appropriate nanomaterials and fabrication techniques. **Attitudes:** Attention to developing a strong interest in exploring how nanosensors can be used to address real-world challenges and a willingness to experiment with new designs, materials, and applications.

3. Syllabus

NANOTECHNOLOGY SEMESTER – V			
Course Code	**M23BEC505B**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**3:0:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course Objectives:

1. To enhance basic engineering science and technical knowledge of nano electronics.
2. To explain the basics of the top-down and bottom-up fabrication process, devices and systems.
3. To describe technologies involved in modern-day electronic devices.
4. To know various nanostructures of carbon and the nature of the carbon bond itself.
5. To learn the physical properties of the sensor used in generating a signal.

Module -1

Introduction: Overview of nano science and engineering. Development milestones in micro fabrication and electronic industry. Moore's law and continued miniaturization, Classification of Nanostructures, Electronic properties of atoms and solids: Isolated atom, Bonding between atoms, Giant molecular solids, Free electron models and energy bands, crystalline solids, Periodicity of crystal lattices, Electronic conduction, effects of nano meter length scale, Fabrication methods: Top-down processes, Bottom-up processes methods for templating the growth of nano materials, ordering of nano systems. Preparation, safety, and storage issues.

Module -2

Characterization: Classification, Microscopic techniques, Electron microscopy, Field ion microscopy, scanning probe techniques, diffraction techniques: bulk and surface diffraction techniques, spectroscopy techniques, surface analysis, depth profiling, techniques for property measurements.

Module -3

Fabrication techniques: Requirements of ideal semiconductor, epitaxial growth of quantum wells, lithography, and etching, cleaved-edge overgrowth, growth of vicinal substrates, strain-induced dots and wires, electro statically induced dots and wires, Quantum well width fluctuations, thermally annealed quantum wells, semiconductor nano crystals, colloidal quantum dots, self-assembly techniques.

Module -4

Carbon Nano tubes: Introduction ,synthesis and purification, filling of nano tubes, mechanism of growth, electronic structure, transport properties, mechanical properties, physical properties, Applications, nano tubes of other materials.

Module -5

Nano sensors: Introduction, What is Sensor? Nano sensors- What makes them Possible?, Order From Chaos, Characterization, Perception, Nano sensors Based On Quantum Size Effects, Electrochemical Sensors, Sensors Based On Physical Properties, Nano biosensors, Smart dust - Sensors of the future.

TEXTBOOKS:

1. Ed Robert Kelsall, Ian Hamley, Mark Geoghegan, "Nano scale Science and Technology", John Wiley, 2007.
2. T Pradeep, "Nano: The Essentials-Understanding Nano science andNanotechnology", TMH.

REFERENCE BOOKS:

1. Charles P Poole, Jr, Frank J Owens, "Introduction to Nanotechnology", JohnWiley, Copyright 2006, Reprint 2011.
2. Ed William A Goddard III, Donald W Brenner, Sergey E. Lyshevski, Gerald J Iafrate, "Hand Book of Nanoscience Engineering and Technology", CRC Press, 2003.

VIDEO LINKS:

1. https://onlinecourses.nptel.ac.in/noc19_mm21/preview

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10

	Total Marks	**50**	**20**

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-3: Introduction	Understand the basics of nano science and engineering, micro fabrication, miniaturization, Classification of Nanostructures, Electronic properties of atoms and solids, Giant molecular solids, Fabrication methods.
2	Week 4-6: Characterization	Introduction to concepts of Classification, Microscopic techniques, Electron microscopy, Field ion microscopy, scanning probe techniques, diffraction techniques, diffraction techniques, spectroscopy techniques, surface analysis.
3	Week 8-11: Fabrication techniques	Introduction to the various fabrication techniques that can be used for preparing nanomaterials like epitaxial growth of quantum wells, lithography, and etching, semiconductor nano crystals, colloidal quantum dots, self-assembly techniques.
4	Week 7-8: Carbon Nano tubes	Understand the synthesis and purification, filling of nano tubes, mechanism of growth, electronic structure, transport properties, mechanical properties, physical properties, Applications, nano tubes of other materials.
5	Week 9-12: Nano sensors	Introduction to concepts of sensors and nano sensors, Electrochemical Sensors, Sensors Based On Physical Properties, Nano biosensors, Smart dust - Sensors.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of Verilog concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with real world competencies.
5	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
6	Laboratory Learning	Utilize the facilities available in the laboratories to understand the behavior of the materials by performing few experiments.

6. Assessment Details (both CIE and SEE) Continuous Internal Evaluation:

The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up

Final CIE Marks =(A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

1. Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Introduction	Understand the basics of nano science and engineering, micro fabrication, miniaturization, Classification of Nanostructures, Electronic properties of atoms and solids, Giant molecular solids, Fabrication methods.
2	Characterization	Apply the basic concepts of Microscopic techniques, Electron microscopy, Field ion microscopy, scanning probe techniques, diffraction techniques, diffraction techniques, spectroscopy techniques, surface analysis.
3	Fabrication techniques	Apply the basic concepts ofvarious fabrication techniques that can be used for preparing nano materials like epitaxial growth of quantum wells, lithography, and etching, semiconductor nano crystals, colloidal quantum dots, and selfassembly techniques.
4	Carbon Nano tubes	Analyze the synthesis and purification, filling of nano tubes, mechanism of growth, electronic structure, transport properties, mechanical properties, physical properties, Applications, and nano tubes of other materials.
5	Nano sensors	Analyze the concepts of sensors and nano sensors, Electrochemical Sensors, Sensors Based On Physical Properties, Nano biosensors, and Smart dust-Sensors.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC505B.1	Comprehend and **apply** the fundamental principles behind Nano science engineering and Nano electronics.
M23BEC505B.2	**Apply** the knowledge to prepare and characterize nanomaterials
M23BEC505B.3	**Analyze** the effect of particles size on mechanical, thermal, optical and electrical properties of nano materials.
M23BEC505B.4	**Analyze** the properties of carbon, carbon nano tubes, the properties used for sensing and the use of smart dust sensors.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC505B.1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC505B.2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC505B.3	3	3	2	-	-	-	-	-	-	-	-	-	3	2
M23BEC505B.4	3	3	2	-	-	-	-	-	-	-	-	-	3	2
M23BEC505B	**3**	**3**	2	-	-	-	-	-	-	-	-	-	3	2

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	Total
Module 1	**10**				**10**
Module 2		**10**			**10**
Module 3			**10**		**10**
Module 4				**10**	**10**
Module 5					**10**
Total	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

10. Future with this Subject:

- Advanced Diagnostics in healthcare: Nanotechnology will enable highly sensitive and specific diagnostic tools, capable of detecting diseases at their earliest stages. For instance, nanosensors and nano particles could lead to ultra-sensitive detection of biomarkers, allowing for earlier and more accurate diagnosis.
- Enhanced Energy Storage: Nano materials will lead to the development of next-generation batteries and super capacitors with higher energy densities, faster charging times, and longer life spans, supporting the growth of electric vehicles and renewable energy storage.
- Environmental Protection: Nano materials will play a key role in cleaning up pollutants, including oil spills, heavy metals, and other environmental contaminants, through advanced filtration and remediation technologies.
- Miniaturization: Nanotechnology will drive further miniaturization of electronic components, leading to faster, more efficient, and more powerful devices with improved performance and lower power consumption.
- Smart Materials: Nanotechnology will enable the creation of smart materials that can respond to environmental changes, such as changes in temperature, pressure, or light, and adapt their properties accordingly.
- Precision Agriculture: Nano sensors and nano materials will improve agricultural practices by monitoring soil conditions, crop health, and environmental factors, leading to more efficient and sustainable farming.
- Advanced Sensors: Nanotechnology will lead to the development of highly sensitive sensors for detecting chemical, biological, radiological, and nuclear threats, improving security and defense capabilities.
- Interdisciplinary Collaboration: The field of nanotechnology will continue to foster interdisciplinary research and collaboration, bringing together scientists, engineers, and researchers from various disciplines to address complex challenges.

5th Semester	Professional Elective Course (PE-I) ARTIFICIAL NEURAL NETWORK	M23BEC505C

1. Prerequisites

S/L	Proficiency	Prerequisites

1	Mathematics:	• Understanding vectors, matrices, and operations on these (like matrix multiplication) is crucial. Concepts like eigen values and eigenvectors can also be important for more advanced topics. • Differentiation and integration are essential particularly for understanding how back propagation works. Partial derivatives and gradient descent are key topics. • Basic concepts like probability distributions, expectation, variance, and statistical inference are useful for understanding various models and evaluating their performance.
2	Programming Skills:	• Most neural network frameworks, like TensorFlow and PyTorch, are written in Python. Being comfortable with Python programming is essential. • Familiarize yourself with libraries such as NumPy (for numerical operations), Pandas (for data manipulation), and Matplotlib or Seabom (for data visualization). Knowledge of deep learning frameworks like Tensor Flow or PyTorch is also important.
3	Computer Science Fundamentals:	• Basic knowledge of algorithms (like sorting and searching) and data structures (like lists, stacks, and queues) is important for understanding more complex neural network operations.

2. Competencies

S/L	Competency	KSA Description
1	Architecture and Learning	**Knowledge:** Understanding of ANN Basics: Familiarity with the fundamentals of ANNs, including concepts like neurons, activation functions, layers (input, hidden, output), and learning algorithms (e.g., back propagation). **Skills:** Ability to design, train, and evaluate neural network models using frameworks like Tensor Flow, Keras, or PyTorch, specifically tailored for architectural applications. **Attitudes:** A commitment to staying updated with advancements in neural network technologies and their applications in architecture.
2	Supervised Learning	**Knowledge:** Understanding basic concepts such as labelled data, training, validation, testing, loss functions, and performance metrics (accuracy, precision, recall, F1 score). **Skills:** Ability to split data into training, validation, and test sets effectively to ensure robust model evaluation. **Attitudes:** An emphasis on making decisions based on data analysis and performance metrics rather than intuition alone.
3	Support Vector Machines and Radial Basis Function	**Knowledge:** Understanding the fundamentals of SVMs, including the concept of hyper planes, margin, and support vectors. Understanding what Radial Basis Functions are and their role in function approximation, classification, and regression. **Skills:** Skills in developing, training, and evaluating SVM models, RBF networks, and hybrid models using appropriate tools and techniques. **Attitudes:** An analytical approach to selecting and combining SVMs, RBFs, and ANNs based on the problem at hand and evaluating their performance critically.
4	Attractor Neural Networks	**Knowledge:**

		Understanding what attractors are in the context of neural networks—states or patterns that the network converges to over time. **Skills:** Skills in designing network architectures that support the desired attractor dynamics, such as configuring Hopfield networks for pattern retrieval. **Attitudes:** An analytical approach to troubleshooting and optimizing attractor neural networks based on experimental results and observations.
5	Self-organization Feature Map	**Knowledge:** Understanding the fundamental principles of Self-Organizing Maps, including how they map high-dimensional data into a lowerdimensional grid while preserving the topological relationships. **Skills:** Skills in tuning SOM parameters, including the grid size, learning rate, and neighbourhood radius, to achieve optimal performance. **Attitudes:** An analytical approach to troubleshooting and optimizing SOMs based on experimental results and observations.

3. Syllabus

ARTIFICIAL NEURAL NETWORK SEMESTER – V			
Course Code	**M23BEC505C**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**3:0:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course Objectives:

1. Understand the role of neural networks in engineering, artificial intelligence, and cognitive modelling
2. Understand the concepts and techniques of neural networks through the study ofimportant neural network models.
3. Evaluate whether neural networks are appropriate to a particular application.
4. Apply neural networks to particular application.
5. Analyze the steps needed to improve performance of the selected neural network.

Module -1

Introduction: Biological Neuron- Artificial Neural Model- Types of activation functions-
Architecture: Feedforward and Feedback, Convex Sets, Convex Hull and Linear Separability, NonLinear Separable Problem. XOR Problem, Multilayer Networks.
Learning: Learning Algorithms, Error correction and Gradient Descent Rules, Learning objective of TLNs, Perception Learning Algorithm, Perception Convergence Theorem.

Module -2

Supervised Learning: Perception learning and Non Separable sets, a.-Least Mean Square Learning, MSE Error surface, Steepest Descent Search, JL-LMS approximate to gradient descent, Application of LMS to Noise Cancelling, Multi-layered Network Architecture, Back propagation Learning Algorithm, Practical consideration of BP algorithm.

Module -3

Support Vector Machines and Radial Basis Function: Learning from Examples, Statistical Learning Theory, Support Vector Machines, SVM application to Image Classification, Radial Basis Function Regularization theory, Generalized RBF Networks, Learning in RBFNs, RBF application to face recognition.

Module -4

Attractor Neural Networks: Associative Learning Attractor Associative Memory, Linear Associative memory, Hopfield Network, application of Hopfield Network, Brain State in a Box neural Network, Simulated Annealing, Boltzmann Machine, Bidirectional Associative Memory.

Module -5
Self-organization Feature Map: Maximal Eigenvector Filtering, Extracting Principal Components, Generalized Learning Laws, Vector Quantization, Self organization Feature Maps, Application of SOM, Growing Neural Gas.
TEXTBOOKS: 1. Neural Networks A Classroom Approach- Satish Kumar, McGraw Hill Education (India) Pvt. Ltd, Second Edition. 2. Introduction to Artificial Neural Systems-J.M. Zurada, Jaico Publications 1994.
REFERENCE BOOKS: 1. Artificial Neural Networks-B. Yegnanarayana, PHI, New Delhi 1998. **VIDEO LINKS:** 1. https://nptel.ac.in/courses/117105084 2. https://www.youtube.com/watch?v=IOa_AYWa5no

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Introduction, Architecture and Learning	Biological Neuron- Artificial Neural Model- Types of activation functions- Feedforward and Feedback, Convex Sets, Convex Hull and Linear Separability, Non-Linear Separable Problem. XOR Problem, Multilayer Networks. Learning Algorithms, Error correction and Gradient Descent Rules, Learning objective of TLNs, Perceptron Learning Algorithm, Perceptron Convergence Theorem.
2	Week 3-4: Supervised Learning	Perceptron learning and Non Separable sets, a.-Least Mean Square Learning, MSE Error surface, Steepest Descent Search, JL-LMS approximate to gradient descent, Application of LMS to Noise Cancelling, Multi-layered Network Architecture, Back propagation Learning Algorithm, Practical consideration of BP algorithm.
3	Week 5-6: Support Vector Machines and Radial Basis Function	Learning from Examples, Statistical Learning Theory, Support Vector Machines, SVM application to Image Classification, Radial Basis Function Regularization theory, Generalized RBF Networks, Learning in RBFNs, RBF application to face recognition.
4	Week 7-8: Attractor Neural Networks	Associative Learning Attractor Associative Memory, Linear Associative memory, Hopfield Network, application of Hopfield Network, Brain State in a Box neural Network, Simulated Annealing, Boltzmann Machine, Bidirectional Associative Memory.
5	Week 9-10: Self-organization Feature Map	Maximal Eigenvector Filtering, Extracting Principal Components, Generalized Learning Laws, Vector Quantization, Self organization Feature Maps, Application of SOM, Growing Neural Gas.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of Neural concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with real world competencies.
5	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies

6	Laboratory Learning	Utilize the facilities available in the laboratories to understand the behavior of the materials by performing few experiments.

6. Assessment Details (both CIE and SEE) Continuous Internal Evaluation:

The minimum CIE marks requirement is 40% of maximum marks in each component. **CIE Split up**

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks =(A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

1. Question paper pattern will be ten questions. Each question is set for 20 marks. The medium of the

question paper shall be English unless otherwise it is mentioned.

2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Introduction, Architecture and Learning	Explore the fundamentals of neural computation by comparing biological neurons to their artificial counterparts, understanding different activation functions, and distinguishing between feedforward and feedback network architectures. Delve into learning algorithms, including error correction, gradient descent, and the Perception Learning Algorithm, emphasizing the learning objectives of threshold logic networks (TLNs) and the Perceptron Convergence Theorem to understand network training and convergence.
2	Supervised Learning	Investigate Perceptron learning with non-separable data, exploring techniques like Least Mean Square (LMS) learning and its application to noise canceling. Delve into the MSE error surface, steepest descent search, and the JL-LMS approximation to gradient descent. Examine multi-layered network architectures and the back propagation learning algorithm, focusing on practical considerations for effective implementation and training.
3	Support Vector Machines and Radial Basis Function	Explore learning from examples through statistical learning theory with Support Vector Machines (SVMs), focusing on their application in image classification. Understand Radial Basis Function (RBF) regularization theory and generalized RBF networks, including their learning mechanisms and applications in face recognition.
4	Attractor Neural Networks	Examine associative learning through attractor neural networks, including linear associative memory and Hopfield networks, which store and retrieve patterns. Explore applications of Hopfield networks, Brain State in a Box, simulated annealing, Boltzmann machines, and bidirectional associative memory for solving complex pattern recognition and optimization problems.
5	Self-organization Feature Map	Explore self-organization through feature maps, including techniques like maximal eigenvector filtering and principal component extraction. Learn about generalized learning laws, vector quantization, and Self-Organizing Maps (SOMs), along with their applications and the concept of Growing Neural Gas for adaptive clustering and data visualization.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC505C.1	Understand and differentiate between biological and artificial neural models, including activation functions and various network architectures such as feedforward and feedback networks..
M23BEC505C.2	Apply Support Vector Machines (SVMs) and Radial Basis Function (RBF) networks for classification and recognition tasks, such as image classification and face recognition.
M23BEC505C.3	Develop and assess supervised learning algorithms, including Perception learning, Least Mean Squares (LMS), and Back propagation. Also the performance of these algorithms in handling non-separable sets, noise cancellation, and multi-layered network architectures.
M23BEC505C.4	Design attractor neural networks and Self-Organizing Maps (SOMs) for pattern recognition, associative memory, and data clustering.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC505C.1	3	3	-	-	-	-	-	-	-	-	-	-	3	3
M23BEC505C.2	-	2	3	3	-	-	-	-	-	-	-	-	-	-
M23BEC505C.3	-	3	-	-	-	3	-	-	-	-	-	-	-	3
M23BEC505C.4	-	-	-	-	3	-	3	-	-	-	-	-	-	-
M23BEC505C	**3**	**2.66**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	Total
Module 1	10				**10**
Module 2	5	5			**10**
Module 3		5	5		**10**
Module 4		5	5		**10**
Module 5				10	**10**
Total	**15**	**15**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	Total
Module 1	**10**	**10**			**20**
Module 2		**20**			**20**
Module 3		**10**	**10**		**20**
Module 4			**10**	**10**	**20**
Module 5			**10**	**10**	**20**
Total	**10**	**40**	**30**	**20**	**100**

10. Future with this Subject:

- **Computer Vision**: Image and Video Analysis: ANNs, particularly convolutional neural networks (CNNs), lead to advancements in image recognition, object detection, and video analysis, impacting areas like autonomous vehicles, security, and medical imaging. Augmented Reality: Neural networks enhance AR applications by enabling real-time object recognition and interaction, enriching user experiences and practical applications.
- **Natural Language Processing (NLP)**: Language Understanding: Deep learning models, including transformers and recurrent neural networks, advance NLP capabilities such as translation, summarization, and sentiment analysis. Conversational Agents: ANNs improve the development of sophisticated chat bots and virtual assistants that understand and generate human-like responses, enhancing user interactions.
- **Data Science and Analytics**: Predictive Modeling: ANNs enhance the ability to build predictive models by analyzing complex datasets, which improves forecasting accuracy and decision-making in fields such as finance, marketing, and healthcare. Pattern Recognition: Advanced neural network

techniques enable the discovery of intricate patterns and correlations in large datasets, aiding in data interpretation and actionable insights.

- **Healthcare and Medicine**: Diagnostic Tools: ANNs support the development of diagnostic tools that analyze medical images, predict disease outcomes, and personalize treatment plans, improving healthcare delivery and patient outcomes. Drug Discovery: Neural networks accelerate drug discovery by modeling complex biological interactions and predicting the efficacy of new compounds.
- **Engineering and Robotics**: Design Optimization: ANNs aid in optimizing engineering designs and processes by analyzing performance data and suggesting improvements, leading to more efficient and innovative solutions. Robotic Control: Neural networks enhance robotic systems by enabling more sophisticated control mechanisms and adaptive behaviors in dynamic environments.
- **Finance and Economics**: Algorithmic Trading: ANNs are used to develop advanced trading algorithms that analyze market trends and execute trades with high precision, improving financial decision-making. Risk Management: Neural networks assist in assessing and managing financial risks by analyzing large volumes of market data and identifying potential threats.
- **Education and Personalized Learning**: Adaptive Learning Systems: ANNs enable the creation of adaptive learning platforms that tailor educational content to individual student needs, improving learning outcomes and engagement. Automated Assessment: AI-driven tools can automate grading and provide personalized feedback, freeing educators to focus on more interactive aspects of teaching.
- **Cyber security**: Threat Detection: ANNs enhance cyber security by identifying and responding to potential threats in real time, improving the ability to detect anomalies and prevent cyber attacks. Behavioral Analysis: Neural networks analyze user behavior patterns to identify potential security risks and develop more robust protective measures.

5th Semester	Professional Elective Course (PE-I) FIBER OPTIC NETWORK	M23BEC505D

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Optical Physics:	• Basic knowledge of different materials and their behaviors under various medium conditions. • Fundamental concepts of reflection, refraction, diffraction, scattering. • Understanding dispersion, mode theory, and interferometer.
2	Mathematics:	• Understanding of solving linear and quadratic equations • Proficiency in differential and integral calculus, including applications. • Familiarity with geometric shapes, angles, trigonometric functions, and their properties.
3	Communication Basics:	• Grasp of communication principles such as transmission and reception, modulation techniques. • Bandwidth and data rate optimizations, noise and signal integrity. • Multiplexing, channel capacity, error detection and correction.
4	Material Science:	• Basic concepts of stress, strain, and material properties like elasticity. • Understanding the material properties such as refractive index, absorption, scattering, and mechanical strength • Fabrication, fiber coatings, and protection, thermal and mechanical properties, and recent advances in fiber materials.
5	Analog and Digital Modulation Schemes:	• Evaluate material strengths and weaknesses, Use tools and modulation schemes in fiber structural analysis. • System design, performance analysis, noise, and interference management. • Ability to think critically and connect concepts within various modulation schemes available.

6	Electro Magnetic (EM) waves:	• Understanding how light can travel within the fiber using light propagation, and waveguide theory. • Understand the EM wave properties related to EMI, and polarization and Apply principles to real-world scenarios. • Ability to use Maxwell's equations, which govern the propagation of light.

2. Competencies

S/L	Competency	KSA Description
1	Introduction to Optical fiber	**Knowledge:** Basic principles of optical fibers, including light propagation, total internal reflection, and the structure of fiber optics (core, cladding, and coating), materials associated with it, such as silica glass and polymers, and their properties. **Skills:** Ability to use fiber optic testing and measurement equipment, proficiency in designing and setting up fiber optic communication systems and networks **Attitudes:** Adhere to safety protocols and embrace continuous learning and professional development to keep up with evolving technologies and methodologies in the fiber optic field.
2	Signal Distortion in Optical Fibers	**Knowledge:** Concepts of different types of signal distortion such as dispersion (chromatic and modal), attenuation, and non-linear effects and their impact on signal quality and performance. **Skills:** Ability to diagnose issues related to signal distortion, such as identifying the sources of dispersion and attenuation. Analytical skills to optimize existing systems to improve performance and reduce the effects of distortion. **Attitudes:** Attention to detail in measurements and analysis to accurately diagnose and address signal distortion issues.
3	Optical sources and detectors	**Knowledge:** Understand the operating principles, advantages, and limitations of LEDs, LASER diodes, p-i-n, and avalanche photodiodes in optical communication.

		Skills: Ability to use test equipment to measure the performance of optical sources and detectors, including their wavelength, power output, and response time. **Attitudes:** Attention to detail in the measurement, testing, and analysis of optical sources and detectors to ensure accuracy, reliability, and solutions for improving performance.
4	Optical Fiber connections and amplifiers	**Knowledge:** Understand the types of fiber optic connections, including fusion splicing, mechanical splicing, couplers, isolators, and types of connectors and their characteristics, applications, and performance specifications. **Skills:** Ability to perform fusion and mechanical splicing with precision, including the use of splicing machines and tools and installing and terminating fiber optic connectors, ensuring low insertion loss and high return loss. **Attitudes:** Attention to detail with a problem-solving mindset, using analytical skills to identify and address issues related to fiber optic connections and amplifiers improving connection quality and amplifier performance.
5	Optical Networks	**Knowledge:** Understand the basic principles of optical networks, including network topologies (e.g., point-to-point, ring, mesh), and the advantages of optical communication over traditional methods, different types of optical networks, such as Passive Optical Networks (PON) and Active Optical Networks (AON) **Skills:** Ability to configure optical network components, including transceivers, switches, and multiplexers, and design optical networks to meet specific performance and capacity requirements. **Attitudes:** Attention to detail in network configuration, testing, and maintenance to ensure high-quality and reliable network performance.

3. Syllabus

FIBER OPTIC NETWORK SEMESTER – V			
Course Code	**M23BEC505D**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**3:0:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course Objectives:

1. To learn the basic principles of optical fiber communication with different modes of light propagation.
2. To analyze various transmission characteristics and losses in an optical fiber.
3. To study various optical components and its applications
4. To learn the network standards in optical fiber and understand the network architecture and its functionalities.

Module -1

Overview of Optical fiber: Electromagnetic spectrum; Optical spectral Bands; The General system; Advantages of fiber optic transmission systems; Basic Optical laws and Definitions - Ray theory transmission - TIR, Numerical Aperture, Acceptance angle; Electromagnetic mode theory Electromagnetic waves, modes in a planar guide, phase and group velocity; Cylindrical fiber-Modes, mode coupling, step-index fibers, graded-index fibers; Single mode fibers-cut-off wavelength, Mode Field Diameter and spot size, Photonic crystal fibers.

Module -2

Signal Distortion in Optical Fibers: Attenuation; Material absorption losses- Intrinsic absorption, Extrinsic absorption, Linear Scattering Losses -Rayleigh, Mie scattering, Nonlinear scattering lossesBrillouin, and Raman Scattering; Fiber Bend Loss; Dispersion, Chromatic Dispersion-Material Dispersion, Waveguide Dispersion, Intermodal Dispersion-Multimode step-index fibre.
Module -3
Optical sources: General source characteristics, LEDs- Principle of operation, surface emitters, Edge emitters, LASER diodes, Fabry-Perot LASER**,** Distributed feedback LASER, Vertical cavity surface emitting LASER **Photodiodes:** The p-i-n Photodiode, Avalanche photodiodes. **Optical Receiver:** Photo detector noise, Noise sources and calculations.
Module -4
Optical Fiber connections: Fiber splices-fusion splices, Fiber couplers, star couplers, Optical Isolators and Circulators. **Optical amplifiers:** Basic application, Semiconductor optical amplifiers, Erbium Doped Fiber Amplifiers, Raman Amplifiers, Wideband Optical Amplifiers.
Module -5
Optical networks: Introduction, Optical networking terminology, Optical network node and switching elements, Wavelength division multiplexed networks, Optical network transmission modes, layers and protocols: Synchronous networks, Asynchronous transfer mode, OSI reference model, Optical transport network, Internet protocol, Wavelength routing networks: Routing and wavelength assignment, Optical switching networks: Optical circuit-switched networks, packet-switched networks, Multiprotocol Label Switching, Optical burst switching networks, Network protection, restoration and survivability.
TEXTBOOKS: 1. John M Senior, Optical Fiber Communications, Principles and Practice, 3rd Edition, Pearson Education, 2010, ISBN:978-81-317-3266-3 2. Gerd Keiser, Optical Fiber Communication, 5th Edition, McGraw Hill 150 Education(India) Private Limited, 2015. ISBN:1-25-900687-5. **REFERENCE BOOKS:** 1. D.K. Mynbaev, S.C. Gupta and Lowell L. Schemer, "Fiber Optic Communications", Pearson Education, 2005. 2. G. P. Agarawal, "Fiber Optics Communication Systems", John Wiley New York, 1997. 3. Joseph C Palais ,"Fiber Optic Communication", 4th Edition, Pearson Education.S S Rattan, Strength of Materials, Second Edition, McGraw Hill, 2011. **VIDEO LINKS:** 1. https://onlinecourses.nptel.ac.in/noc23_ee80/preview

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-3: Overview of Optical fiber	Understand the basics of light propagation in the form of ray and wave theory, types of optical fibers, and modes of operation of the fiber.
2	Week 4-6: Signal Distortion in Optical Fibers	Introduction to concepts of signal distortion such as attenuation,Material absorption losses, Linear and Nonlinear scattering, Dispersion and their effects on optical fiber during transmission of signals.
3	Week 8-11: Optical sources and Receivers	Introduction to the various optical components that can be used for communication in a channel and their behaviour, general characteristics, principle of operation as sources and detectors.
4	Week 7-8: Optical Fiber connections and amplifiers	Understand the various types of connections that can be adapted for an optical fiber while using for communication like Fiber splices, Fiber couplers, Optical Isolators and Circulators. Basic principle of operation of Semiconductor optical amplifiers, Erbium Doped Fiber Amplifiers, Raman Amplifiers, and Wideband Optical Amplifiers.

5	Week 9-12: Optical networks	Introduction to concepts of optical networks, node and switching elements, Wavelength division multiplexed networks, and protocols, Internet protocol, Wavelength routing networks and Optical switching networks, Network protection, restoration and survivability.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of Verilog concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with real world competencies.
5	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
6	Laboratory Learning	Utilize the facilities available in the laboratories to understand the behavior of the materials by performing few experiments.

6. Assessment Details (both CIE and SEE) Continuous Internal Evaluation:

The minimum CIE marks requirement is 40% of maximum marks in each component. **CIE Split up**

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks =(A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

1. Question paper pattern will be ten questions. Each question is set for 20 marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks.

7. Learning Objectives

S/L	Learning Objectives	Description
1	Optical fiber	Understand the basics of light propagation in the form of ray and wave theory, types of optical fibers, and modes of operation of the fiber.
2	Signal Distortion in Optical Fibers	Apply concepts of signal distortion such as attenuation, material absorption losses, linear and nonlinear scattering, and dispersion, as well as their effects on optical fiber during the transmission of signals.
3	Optical sources and detectors	Analyze the various optical components that can be used for communication in a channel and their behavior, general characteristics, and principle of operation as sources and detectors.

4	Optical Fiber connections and amplifiers	Understand the various types of connections, fiber couplers, optical isolators, and circulators. Analyze the Basic principle of operation of Semiconductor optical amplifiers, Erbium Doped Fiber Amplifiers, Raman Amplifiers, and Wideband Optical Amplifiers.
5	Optical Networks	Apply concepts of optical networks, node and switching elements, Wavelength division multiplexed networks, protocols, Internet protocol, Wavelength routing networks, and Optical switching networks.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC505D.1	**Explain** the fundamental concepts of optical fiber transmission, fiber modes and its components.
M23BEC505D.2	**Apply** the optical fiber concepts in optical fiber connectors, networking aspects, transmission links, Amplifiers and WDM
M23BEC505D.3	**Analyze** the channel impairments and components commonly used in an optical fiber communication system.
M23BEC505D.4	**Analyze** the optical fiber communication link, structure, propagation, fiber configurations, and modes of transmission.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC505D.1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC505D.2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC505D.3	3	3	2	-	-	-	-	-	-	-	-	-	3	2
M23BEC505D.4	3	3	2	-	-	-	-	-	-	-	-	-	3	2
M23BEC505D	**3**	**3**	2	-	-	-	-	-	-	-	-	-	3	2

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	Total
Module 1	**10**				**10**
Module 2		**10**			**10**
Module 3			**10**		**10**
Module 4				**10**	**10**
Module 5					**10**
Total	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

10. Future with this Subject:

- **Increased Speed and Capacity**: As technology advances, fiber optic networks will continue to offer faster data transmission speeds and greater bandwidth. Innovations like Dense Wavelength Division Multiplexing (DWDM) are expected to further enhance the capacity of fiber networks.
- **Expansion of Fiber to the Home (FTTH):** The rollout of FTTH will continue to expand, providing high-speed internet access to more residential areas. This expansion will support the growing demand for high-bandwidth applications and services.
- **Integration with 5G**: Fiber optics will play a crucial role in supporting 5G networks. Fiber will be used for backhaul and front haul connections, ensuring that the high-speed, low-latency requirements of 5G are met.
- **Enhanced Reliability and Lower Latency**: Fiber optic networks are known for their reliability and low latency. Future advancements will further improve these qualities, making fiber optics even more suitable for critical applications like real-time data processing and autonomous systems.
- **Quantum Communication**: Research into quantum communication and quantum key distribution (QKD) is progressing, and fiber optics could play a key role in these technologies, offering unprecedented levels of security.
- **Undersea Cables**: The development and deployment of new undersea fiber optic cables will continue to improve global connectivity, supporting the increasing demand for international data traffic.
- **Smart Cities and IoT**: Fiber optics will be essential in the development of smart cities and the Internet of Things (IoT). High-speed, reliable connections are critical for the massive amounts of data generated by connected devices and systems.
- **Cost Reduction**: As fiber optic technology becomes more widespread and manufacturing techniques improve, the cost of deploying fiber networks is expected to decrease, making it more accessible for various applications.

5th Semester	Project Work (PW) MINI PROJECT WORK	M23BEC506

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Engineering Principles	Fundamental courses in the respective engineering stream

2	Application of Theoretical Knowledge in Practical Scenarios	Knowledge of the core subjects of the respective stream
3	Project Design and Planning	Familiarity with design tools and project management techniques.
4	Multidisciplinary Collaboration	Basic knowledge of related disciplines (e.g., Electronics students should have a basic understanding of Mechanical, etc.).
5	Technical Communication	Writing technical reports and presenting technical content

2. Competencies

S/L	Competency	KSA Description
1	Problem Identification and Analysis	**Knowledge:** Understanding the problem domain and relevant engineering concepts. **Skill:** Ability to analyze and break down complex problems into manageable parts. **Attitude:** Attention to detail and a systematic approach to problem-solving.
2	Solution Design and Implementation	**Knowledge:** Familiarity with design methodologies and tools. **Skill:** Proficiency in creating prototypes or models using appropriate technologies. **Attitude:** Creativity and innovation in developing solutions.
3	Interdisciplinary Collaboration	**Knowledge:** Understanding of basic concepts from other engineering disciplines. **Skill:** Effective communication and teamwork in a multidisciplinary environment. **Attitude:** Openness to different perspectives and willingness to collaborate.
4	Technical Documentation and Presentation	**Knowledge:** Standards and practices for technical writing and reporting. **Skill:** Ability to document the project effectively and present it to an audience. **Attitude:** Confidence and clarity in communication.
5	Project Management	**Knowledge:** Understanding of project timelines, resource allocation, and risk management. **Skill:** Ability to plan, execute, and monitor a project from start to finish. **Attitude:** Responsibility and accountability in managing project tasks.

3. Project Timeline

S/L	Timeline	Description
1	Week 1-2: Introduction and Problem Definition	Students will define their project problem, scope, and objectives with the guidance of their mentors.
2	Week 3-4: Research and Feasibility Study	Conduct background research, explore existing solutions, and evaluate the feasibility of different approaches.
3	Week 5-6: Design and Planning	Develop a detailed project plan, including design specifications, timelines, and resource requirements.
4	Week 7-8: Prototype Development	Begin building the initial prototype or model, focusing on core functionalities.
5	Week 9-10: Testing and Refinement	Test the prototype, identify issues, and refine the design to improve performance.
6	Week 11: Final Implementation and Documentation	Complete the final implementation of the project and prepare detailed documentation.

7	Week 12: Presentation and Evaluation	Present the project to a committee for evaluation, followed by a Q&A session.

4. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation:
The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.
The CIE marks awarded for the project work, shall be based on the evaluation of the project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.
SEE: There shall be no SEE.

5. Learning Objectives

S/L	Learning Objectives	Description
1	Identify and Analyze Engineering Problems	Students will learn to identify real-world engineering problems, analyze them, and propose feasible solutions.
2	Design and Implement Solution(s)	Students will gain experience in designing and implementing engineering solutions using appropriate tools and methodologies.
3	Collaborate Effectively in Teams	Students will develop teamwork skills through collaboration with peers from different engineering disciplines.
4	Communicate Technical Information	Students will enhance their ability to document and present technical information effectively.

6. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC506.1	Apply engineering principles to identify, formulate, and solve real-world problems.
M23BEC506.2	Design and develop prototypes or models that address specific engineering challenges.
M23BEC506.3	Collaborate with team members to complete the project successfully.
M23BEC506.4	Document and present the project effectively, demonstrating clear communication skills.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC506.1														
M23BEC506.2														
M23BEC506.3														
M23BEC506.4														
M23BEC506														

7. Future with this Subject

The mini-project course will serve as a foundation for more complex and comprehensive project work in the final year, such as the capstone project. The skills developed here, including problem-solving, design, teamwork, and communication, will be crucial for successful completion of future courses and for professional practice in engineering.

5th Semester	Ability Enhancement Course (AE) RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS	M23BRMK507

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Understanding of Research Concepts	Before delving into the specifics of engineering research and intellectual property rights, students should have a foundational understanding of what research is, its objectives, and its significance, particularly in the context of engineering.
2	Familiarity with Ethics in Research	Basic knowledge of ethics, including common ethical dilemmas and misconduct in research, is essential. This includes understanding issues related to authorship and ethical considerations in the research process.
3	Literature Review Skills	Students should have prior experience in conducting literature reviews, including familiarity with bibliographic databases such as Web of Science, Google Scholar, and effective search strategies. This will help them in understanding and analyzing existing knowledge in their research field.
4	Introduction to Intellectual Property Rights	A preliminary understanding of intellectual property rights, including patents, copyrights, trademarks, and industrial designs, would be beneficial. This knowledge should include the role of IP in society and basic IP laws, especially in the Indian context.
5	Technical Reading and Writing Skills	Competence in reading and comprehending technical documents, including research papers, datasheets, and legal texts, is crucial. Additionally, students should have basic knowledge of how to structure a journal paper and the importance of proper citation and attribution in academic writing.

2. Competencies

S/L	Competency	KSA Description
1	Understand the research process	Knowledge: Types of research (exploratory, descriptive, explanatory, etc.) Research methodologies (qualitative, quantitative, mixed) Research design (experimental, correlation, causal-comparative) Research ethics principles Skills: Identify research problems, Formulate research questions and objectives, Develop research proposals, Conduct literature reviews Attitudes: Curiosity and inquisitiveness, Critical thinking and problem-solving, Intellectual honesty and integrity
2	Apply ethical principles to research	Knowledge: Ethical guidelines for research Ethical issues in research (plagiarism, data fabrication, etc.) Researcher-participant relationships Skills: Identify potential ethical dilemmas in research Develop ethical protocols for research Obtain informed consent from participants Attitudes: Respect for human subjects, Commitment to research integrity Responsibility for the ethical conduct of research
3		Knowledge: Sources of research literature (databases, journals, books) Literature review structure and organization

	Conduct effective literature reviews	Critical appraisal of research articles Skills: Search for relevant research literature, Evaluate and synthesize research findings, Organize and present literature review findings Attitudes: Persistence and thoroughness, Open-mindedness to different perspectives, Attention to detail
4	Design research studies	Knowledge: Research designs (experimental, correlational, causal-comparative), Sampling techniques, Data collection methods (surveys, interviews, observations) Skills: Develop research instruments, Select appropriate research design, Develop data collection plans Attitudes: Creativity and innovation, Flexibility and adaptability, Attention to detail
5	Understand the concept of intellectual property	Knowledge: Definition and types of intellectual property (patents, copyrights, trademarks, trade secrets, industrial designs) Legal framework for intellectual property protection Economic and social importance of intellectual property Skills: Identify intellectual property assets within an organization or project Understand the basics of intellectual property valuation Attitudes: Appreciation for the value of intellectual property, Respect for intellectual property rights, Awareness of intellectual property issues in business and research

3. Syllabus

RESEARCH METHODOLOGY & INTELLECTUAL PROPERTY RIGHTS SEMESTER – V			
Course Code	M23BRMK507	CIE Marks	50
Number of Lecture Hours/Week(L: T: P: S)	(1:2:0:0)	SEE Marks	50
Total Number of Lecture Hours	25 hours Theory	Total Marks	100
Credits	02	Exam Hours	03

Course Objectives:

1. To know the meaning of engineering research.
2. To know the procedure of Literature Review and Technical Reading.
3. To know the fundamentals of patent laws and drafting procedure.
4. To gain awareness of the copyright laws and subject matters of copyrights and designs.
5. To interpret and learn the basic principles of design rights.

Module -1

Introduction: Meaning of research, objectives of engineering research, and motivation in engineering research, types of engineering research, finding and solving a worthwhile problem.

Ethics in engineering research: Ethics in engineering research practice, types of research misconduct, and ethical issues related to authorship.

Module -2

Journal Paper document: structure and approach, Literature Review and Technical Reading: New and existing knowledge in research field, analysis and synthesis of prior art. Bibliographic databases like web of science, Google and Google scholar. Effective search: the way forward, introduction to technical reading conceptualizing research, critical and creative reading, taking notes while reading, reading mathematics and algorithms, reading a datasheet.

Attributions and Citations: Giving credit wherever due, citations: functions and attributes, impact of title and keywords on citations, knowledge flow through citation, styles for citations, citing datasets,

acknowledgments and attributions, what should be acknowledged, acknowledgments in books and dissertations, dedication vs. acknowledgments.

Module -3

Introduction to Intellectual Property (IP): Role of IP in the economic and cultural development of the society, IP governance, IP as a global indicator of innovation, origin of IP, history of IP in India. Major amendments IP laws and acts in India. IP Organizations in India, schemes and programs.

Patents: Conditions for obtaining a patent protection, to patent or not to patent an invention. Rights associated with patents and enforcement of patent rights. Non-patentable matters. Patent infringements and avoiding public disclosure of an invention before patenting.

Process of Patenting: Prior art search, choice of application to be filed, patent application forms, fee structure, types of patent applications. Jurisdiction of filing patent application, publication, pre-grant opposition, examination, and grant of a patent. Validity of patent protection, post-grant opposition, and commercialization of a patent. Need for a patent attorney/ agent. Can a worldwide patent be obtained? Do I need first to file a patent in India? Commonly used terms in patenting, National bodies dealing with patent affairs, utility models.

Case Studies on Patents. Case study of Curcuma (Turmeric) Patent, Case study of Neem Patent, Case study of Basmati patent.

Module -4

Copyrights and Related Rights: Classes of copyrights, criteria for copyright, ownership of copyright, and copyrights of the author. Copyright infringement a criminal offence and cognizable offence. Fair use doctrine. Copyrights and internet. Non-copyright work. Copyright registration. Judicial powers of the registrar of copyrights. Fee structure, copyright symbol, validity of copyright, copyright profile of India. Transfer of copyrights to a publisher. Copyrights and the words 'adaptation', 'Indian work', 'joint authorship', 'publish'. Copyright society, copyright board, and copyright enforcement advisory council (CEAC). International copyright agreements, conventions and treaties.

Case Studies of Copyrights cases: Hawkins Cooker Ltd. vs. Magicook Appliances, KSRTC copyright case. Trademarks registration: prior art search, eligibility criteria, who can apply for a trademark. Acts and laws. Designation of trademark symbols. Classification of trademarks. Registration of a trademark is not compulsory. Validity of trademark. Types of trademark registered in India. Trademark registry and process for trademarks registration. Case Studies on Trademarks: Coca-cola company vs. Bisleri international PVT. Ltd, and Yahoo! Inc. vs. Akash Arora & Anr

Module -5

Industrial Designs: Eligibility criteria, Acts and laws to govern industrial designs. Design rights. Enforcement of design rights. Non-protectable industrial designs India. Protection term. Procedure for registration of industrial designs: Prior art search, application for registration, duration of the registration of a design. Importance of design registration. Cancellation of the registered design. Application forms.

Classification of industrial designs. Designs registration trend in India. International treaties.

Famous case of: Apple inc. vs. Samsung electronics co.

Geographical Indications (GI): acts, laws and rules pertaining to GI. Ownership of GI. Rights granted to the holders. Registered GI in India. Identification of registered GI. Classes of GI. Non-registerable GI. Protection of GI. Collective or certification marks. Enforcement of GI rights. Procedure for GI registration documents required for GI registration. GI ecosystem in India.

Case Studies on GI tags: Case Study of Mysore Silk, Darjeeling Tea, Kancheepuram Silk Sarees, case of Goa's Feni

Text Books:

1. Dipankar Deb • Rajeeb Dey, Valentina E. Balas "Engineering Research Methodology", ISSN 18684394 ISSN 1868-4408 (electronic), Intelligent Systems Reference Library, ISBN 978-981-13- 2946-3 ISBN 978-981-13-2947-0 (eBook), https://doi.org/10.1007/978-981-13-2947-0
2. KOTHARI, C. R. (2004). "Research methodology: Methods and techniques". New age international. 3. Intellectual Property A Primer for Academia by Prof. Rupinder Tewari Ms. Mamta Bhardwa Reference Book:
   1. David V. Thiel "Research Methods for Engineers" Cambridge University Press, 978-1-107-03488- 4
   2. Intellectual Property Rights by N.K. Acharya Asia Law House 6th Edition. ISBN: 978-93 81849-30-9

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-3: Introduction to Research and Intellectual Property	Week 1: Research fundamentals, types of research, research process, ethics Week 2: Intellectual property overview, patents, trademarks Week 3: Copyrights, industrial designs, geographical indications
2	Week 4-6: Literature Review, Research Design, and Data Analysis	Week 4: Literature review, bibliographic databases, citation styles Week 5: Research design, sampling, data collection methods Week 6: Data analysis techniques, research ethics case study
3	Week 7-9: Intellectual Property Law and Enforcement	Week 7: Patent law, patent search, patent drafting Week 8: Trademark law, trademark search, brand management Week 9: Copyright law, fair use, digital copyright
4	Week 10-12: Intellectual Property and Business	Week 10: Intellectual property valuation, licensing, and commercialization Week 11: Intellectual property strategy and management Week 12: Case studies on intellectual property disputes
5	Week 13	Review and Final Exam

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of research methodology concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
5	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies

6. Assessment Details (both CIE and SEE) Continuous Internal Evaluation:

The minimum CIE marks requirement is 40% of maximum marks in each component. CIE Split up

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			50	20

Final CIE Marks =(A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

1. Question paper pattern will be ten questions. Each question is set for 20 marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understand the fundamental principles of research methodology.	Research objectives should be clear and based on curiosity. A systematic approach, inspired by the scientific method, ensures transparency and replication. The goal should be to add something new or distinctive, exploring and questioning existing knowledge.
2	Apply ethical considerations in engineering research.	Students as researchers must obtain informed consent from study participants, ensure voluntary participation, protect participant identities and confidentiality, prevent harm to participants, and submit proposals to an institutional review board (IRB) for ethical approval before data collection, ensuring compliance with research objectives and balancing safety with research objectives.
3	Conduct effective literature reviews and technical reading.	Students will learn to conduct a literature review, start by searching for relevant sources, evaluating and selecting them based on quality and relevance, identifying themes, debates, and gaps, outlining your findings logically, and writing your review. Analyze, critique, and compare different sources, highlighting how your research contributes to the ongoing scholarly conversation.
4	Identify and utilize proper attribution and citation styles.	Different disciplines use specific citation styles, such as APA, MLA, or Chicago. In-text citations include author's name and publication year. Reference lists or bibliographies should be compiled at the end of the work. Book citations include author(s), title, publisher, and publication year. Journal article citations include author(s), title, journal name, volume, issue, and publication year.
5	Gain knowledge of different forms of intellectual property (IP) protection.	Patents, copyrights, and trade secrets are legal rights granted by government agencies to inventors, protecting novel processes, machines, and compositions of matter. Trademarks safeguard brand names and symbols, while trade secrets provide confidential information for competitive advantage.
6	Understand the patenting process and its importance. Recognize the significance of copyrights, trademarks, industrial designs, and geographical indications.	A patent is a legal shield granted by a government authority to inventors, providing exclusive rights to an original invention. There are three main types: utility patents, plant patents, design patents, trademarks, copyrights, industrial designs, and geographical indications. Utility patents cover inventions like machines, software, and chemical formulations, while plant patents safeguard unique plant characteristics. Design patents protect product ornamental appearance. Trademarks help build brand identity and prevent confusion.

7	Identify relevant IP organizations and government schemes in India.	The Indian government initiatives include CIPAM, IPRs in School Syllabus, Patent Facilitation Program, National IPR Policy, Technology and Innovation Support Centers, Start-up India, Make in India, National IP Awards, Patent Prosecution Highway, border measures, and support for startups and MSMEs.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BRMK507.1	Interpret the ethical issues in engineering research, including identifying types of research misconduct and evaluating the impact of ethical practices on research outcomes.
M23BRMK507.2	Analyze literature from diverse bibliographic databases, critically appraise existing research, and synthesize prior art to develop a comprehensive understanding of a chosen research topic.
M23BRMK507.3	Apply appropriate citation styles and techniques, ensuring proper attributions in academic writing to maintain ethical standards and enhance the credibility of research work.
M23BRMK507.4	Apply the principles of intellectual property rights, including patents, copyrights, and trademarks, to assess the eligibility of an invention or creative work for protection, and navigate the processes for registration and enforcement.
M23BRMK507.5	Analyze the role of intellectual property in economic and cultural development, and explain the historical evolution and contemporary relevance of IP laws and acts, particularly in the Indian context.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BRMK507.1	3	-	-	3	-	-	-	3	-	-	-	3	-	-
M23BRMK507.2	-	3	-	3	3	-	-	-	-	3	-	3	3	3
M23BRMK507.3	-	-	-	-	3	-	-	3	-	3	-	3	-	-
M23BRMK507.4	-	3	-	3	-	-	-	-	-	3	-	-	3	-
M23BRMK507.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
M23BRMK507	3	3	-	3	3	-	-	3	-	3	-	3	3	3

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	10					10
Module 2		10				10
Module 3			10			10
Module 4				10		10
Module 5					10	10
Total	10	10	10	10	10	50

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	20					20
Module 2		20				20

Module 3			20			20
Module 4				20		20
Module 5					20	20
Total	20	20	20	20	20	100

10. Future with this Subject:

1. Advanced Research Opportunities:

- PhD and Postdoctoral Research: The course equips mechanical engineers with essential research skills, making them strong candidates for advanced studies. This can lead to specialization in emerging fields like computational mechanics, renewable energy systems, and smart manufacturing.

- Interdisciplinary Research: Understanding research methodology enables mechanical engineers to collaborate on interdisciplinary projects, combining mechanical engineering with fields like materials science, robotics, and artificial intelligence.

2. Innovation and Product Development:
   - Patentable Innovations: Knowledge of intellectual property rights allows engineers to protect their innovations, leading to the development of patentable technologies. This is particularly relevant in industries like automotive, aerospace, and manufacturing, where innovation is key to competitiveness.

   - Start-ups and Entrepreneurship: The course provides a foundation for engineers to start their own ventures, focusing on innovative mechanical products or services. Understanding IP can help secure funding and protect their business ideas.

3. Career in Research and Development (R&D):
   - Industry R&D Roles: Mechanical engineers with strong research methodology skills are valuable assets in R&D departments. They can lead projects that require rigorous research, data analysis, and the development of new technologies or processes.

   - Government and Private Research Organizations: Opportunities in organizations like CSIR (Council of Scientific & Industrial Research), DRDO (Defense Research and Development Organization), or private research labs, where engineers can contribute to national and international projects.

4. Consulting and Advisory Roles:
   - IP Consulting: Engineers with expertise in intellectual property rights can work as consultants, advising companies on patenting strategies, IP management, and innovation protection.

   - Research Methodology Expert: Mechanical engineers can also serve as advisors or consultants for research projects, helping organizations design and implement robust research methodologies.

5. Teaching and Academia:
   - Faculty Positions: With advanced knowledge in research methodology and IP, mechanical engineers can pursue teaching careers in universities or technical institutes, contributing to the next generation of engineers.

   - Curriculum Development: They can also be involved in developing or enhancing engineering curricula, incorporating modern research methods and IP considerations into mechanical engineering programs.

6. Contribution to Sustainable Development:
   - Innovations for Sustainability: Mechanical engineers can apply their research skills to develop sustainable technologies, focusing on renewable energy, energy efficiency, and reducing the environmental impact of mechanical systems.

   - Policy Making: With an understanding of the societal impact of engineering solutions, they can contribute to policy-making processes, particularly in areas related to environmental sustainability and technology regulation.

This course lays the foundation for mechanical engineers to not only excel in their current roles but also to explore new horizons in research, innovation, and entrepreneurship, making a significant impact on their field and society.

5th Semester	Basic Science Course (BS) ENVIRONMENTAL STUDIES	M23BESK508

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Understanding Ecosystems	Basic knowledge of biology, environmental science, and ecological systems.
2	Comprehending Natural Resource Management	Familiarity with energy systems, environmental management, and global sustainability practices.
3	Knowledge of Environmental Pollution	Understanding of chemical processes, industrial impacts, and environmental science fundamentals.
4	Addressing Global Environmental Concerns	Knowledge of climate science, environmental policies, and global ecological challenges.
5	Awareness of Environmental Legislation	Familiarity with national and international environmental laws, policies, and regulations.

2. Competencies

S/L	Competency	KSA Description
1	Ecosystem Analysis	**Knowledge**: Ecosystem structure, sustainability principles, SDGs. **Skills**: Identifying ecosystem components, and understanding sustainability targets. **Attitudes**: Appreciating biodiversity, and promoting sustainability.
2	Resource Management	**Knowledge**: Renewable and non-renewable energy systems, sustainable practices. **Skills**: Analyzing case studies, and evaluating energy systems. **Attitudes**: Supporting sustainable resource use, and critical thinking on global issues.
3	Pollution Mitigation	**Knowledge**: Pollution sources, impacts, and legislation. **Skills**: Assessing pollution control measures, and implementing waste management strategies. **Attitudes**: Advocating for environmental protection, and responsible waste disposal.
4	Global Environmental Awareness	**Knowledge**: Climate change, groundwater depletion, global policies. **Skills**: Investigating global environmental challenges, and proposing solutions. **Attitudes**: Engaging in global environmental discussions, and supporting international efforts.
5	Environmental Legal Framework	**Knowledge**: Key environmental acts and regulations. **Skills**: Applying legal knowledge to environmental issues, and understanding EIA processes. **Attitudes**: Valuing legal frameworks, and ensuring compliance with environmental laws.

3. Syllabus

ENVIRONMENTAL STUDIES SEMESTER – V			
Course Code	**M23BESK508**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**2:0:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**25 hours Theory**	Total Marks	**100**
Credits	**02**	Exam Hours	**02**

Course Objectives: Students will be able

1. Understand the structure and function of various ecosystems like forests, deserts, wetlands, rivers, oceans, and lakes.
2. Explore natural resource management techniques, including energy systems and disaster management, and assess their sustainability.
3. Examine environmental pollution sources and impacts, and learn corrective and preventive measures alongside waste management strategies.
4. Investigate global environmental issues such as climate change and groundwater depletion, and the role of environmental legislation in addressing these issues.

Module -1

ECOSYSTEMS (STRUCTURE AND FUNCTION): Forest, Desert, Wetlands, River, Oceanic and Lake. Sustainability: 17 SDGs- History, targets, implementation , Capacity Development

Module -2

NATURAL RESOURCE MANAGEMENT Advances in Energy Systems (Merits, Demerits, Global Status and Applications): Hydrogen, Solar, OTEC, Tidal and Wind. Natural Resource Management (Concept and case-studies): Disaster Management, Sustainable Mining - case studies and Carbon Trading.
Module -3
ENVIRONMENTAL POLLUTION & WASTE MANAGEMENT Environmental Pollution (Sources, Impacts, Corrective and Preventive measures, Relevant Environmental Acts, Case-studies): Surface and Ground Water Pollution; Noise pollution; Soil Pollution and Air Pollution. Waste Management: Biomedical Wastes; Solid waste; Hazardous wastes; E-wastes; Industrial and Municipal Sludge.
Module -4
Global Environmental Concerns (Concept, policies and case-studies): Ground water depletion/recharging, Climate Change; Acid Rain; Ozone Depletion; Radon and Fluoride problem in drinking water; Resettlement and rehabilitation of people, Environmental Toxicology.
Module -5
ENVIRONMENTAL LEGISLATION: Water Act 1974, Air Act 1981, Environmental Protection Act 1984, Solid Waste Management Rules-2016, E- Waste Management Rule - 2022, Biomedical Waste management- 2016. Environmental Impact Assessment
TEXTBOOKS: 1. Environmental studies, Benny Joseph, Tata Mcgraw-Hill 2nd edition 2012 2. Environmental studies, S M Prakash, pristine publishing house, Mangalore 3rd edition -2018 **REFERENCE BOOKS:** 1. Benny Joseph, Environmental studies, Tata Mcgraw-Hill 2nd edition 2009 2. M. Ayi Reddy Textbook of Environmental Science and Technology, BS publications 2007 3. Dr. B.S Chauhan, Environmental studies, university of Science Press 1st edition **VIDEO LINKS:** 1. Weblink:https://sdgs.un.org/goals Video Lectures 2. https://archive.nptel.ac.in/courses/109/105/109105190/ .

5. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2	Introduction to ecosystems, exploring their structure and function with a focus on sustainability and SDGs.
2	Week 3-4	Understanding natural resource management, advances in energy systems, and disaster management through case studies.
3	Week 5-6	Examination of environmental pollution sources, impacts, and preventive measures, along with waste management strategies.
4	Week 7-8	Exploration of global environmental concerns such as climate change, groundwater depletion, and related policies.
5	Week 9-10	Study of environmental legislation, including key environmental acts and the process of Environmental Impact Assessment (EIA).
6	Week 11-12	Revision

4. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Interactive Lectures:	Utilize chalk and talk along with PowerPoint presentations and animations to engage students in theoretical and practical understanding
2	Case Study Analysis:	Present real-world scenarios and case studies to help students apply theoretical knowledge to practical situations, particularly in natural resource management and pollution control.

3	Fieldwork and Site Visits	Encourage hands-on learning through field visits to environmental labs, green buildings, and treatment plants, followed by documentation and analysis of the processes observed.
4	Collaborative Learning	Promote group projects and discussions, enabling students to collaborate and learn from each other, particularly in global environmental concerns and energy systems.

5. Assessment Details (both CIE and SEE)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

1. For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
2. The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
3. Any two assignment methods mentioned in the regulations, if an assignment is projectbased then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
4. For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

The sum of two tests, two assignments, will be out of 100 marks and will be scaled down to 50 marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for **50 questions**, each of the 01 marks. **The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is 01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

6. Learning Objectives

S/L	Learning Objectives	Description
1	Analyze the structure and function of various ecosystems.	Students will learn about the characteristics and interactions within ecosystems such as forests, deserts, wetlands, rivers, oceans, and lakes.
2	Evaluate natural resource management techniques.	Students will assess the merits and demerits of various energy systems and learn sustainable management practices through case studies.
3	Investigate environmental pollution and waste management.	Students will understand the sources and impacts of environmental pollution, along with strategies for pollution control and waste management.
4	Explore global environmental	Students will study global issues like climate change and groundwater depletion, and examine the role of environmental legislation in addressing these challenges.

	concerns and policies.	
5	Understand environmental legislation and its application.	Students will gain insights into key environmental acts and regulations, and learn how to apply them in real-world scenarios.

7. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BESK508.1	Analyze the structure and functions of various ecosystems and evaluate their sustainability
M23BESK508.2	Apply knowledge of natural resource management and advances in energy systems to assess their global impacts
M23BESK508.3	Investigate environmental pollution sources and apply waste management strategies in real-world scenarios
M23BESK508.4	Critically analyze global environmental concerns and assess the effectiveness of environmental policies
M23BESK508.5	Demonstrate an understanding of environmental legislation and apply it to ensure sustainable practices

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M23BESK508.1	3	-	-	-	-	-	-	-	-	-	-	3
M23BESK508.2	-	3	-	-	-	-	-	-	-	-	-	3
M23BESK508.3	-	-	3	-	-	-	-	-	-	-	-	3
M23BESK508.4	-	-	-	3	-	-	-	-	-	-	-	3
M23BESK508.5	-	-	-		3	-	-	-	-	-	-	3
M23BESK508	**3**	**3**	**3**	**3**	**3**	-	-	-	-	-	-	**3**

8. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**10**					**10**
Module 2		**10**				10
Module 3			**10**			10
Module 4				**10**		10
Module 5					**10**	10
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**20**					20
Module 2		**20**				20
Module 3			**20**			20

Module 4				**20**		20
Module 5					**20**	20
Total	**20**	**20**	**20**	**20**	**20**	**100**

9. Future with this Subject

This course provides a foundational understanding of environmental science that is crucial for advanced studies in environmental engineering, sustainability, and policy-making. It equips students with the knowledge and skills to tackle global environmental challenges and supports interdisciplinary research, making it a valuable asset for careers in environmental management, consulting, and advocacy. The insights gained from this course will also be beneficial in professional roles requiring compliance with environmental legislation and sustainable development practices.

5th Semester	Non Credit Mandatory Course (NCMC) NATIONAL SERVICE SCHEME (NSS)	M23BNSK509

NATIONAL SERVICE SCHEME (NSS)			
Course Code	**M23BNSK509**		
Number of Lecture Hours /Week (L:T:P:S)	**0:0:2:0**	CIE Marks	**100**
Total Number of Lecture Hours		SEE Marks	**-**
Credits	**0**	Total Marks	**100**
Activities Report Evaluation by College NSS Officer at the end of every semester (3rd to 6th semester)			

Course objectives:

National Service Scheme (NSS) will enable students to:

1. Understand the community in general in which they work.
2. Identify the needs and problems of the community and involve them in problem–solving.
3. Develop among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems.
4. Develop competence required for group- living and sharing of responsibilities & gain skills in mobilizing community participation to acquire leadership qualities and democratic attitudes.
5. Develop capacity to meet emergencies and natural disasters & practice national integration and social harmony in general.

General Instructions-Pedagogy:

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the activities will develop students' theoretical and applied social and cultural skills.
2. State the need for NSS activities and its present relevance in society and Provide real-life examples.
3. Support and guide the students for self-planned activities.
4. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress in real activities in the field.
5. Encourage the students for group work to improve their creative and analytical skills.

Contents:

1. Organic farming, Indian Agriculture (Past, Present and Future) Connectivity for marketing.
2. Waste management–Public, Private and Govt organization, 5R's.
3. Setting of the information imparting club for women leading to contribution in social and economic issues.
4. Water conservation techniques–Role of different stakeholders–Implementation.
5. Preparing an actionable business proposal for enhancing the village income and approach for implementation.
6. Helping local schools to achieve good results and enhance their enrolment in Higher /technical /vocational education.
7. Developing Sustainable Water management system for rural areas and implementation approaches.
8. Contribution to any national level initiative of Government of India. For eg. Digital India, Skill India, Swatch Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc.
9. Spreading public awareness under rural outreach programs. (minimum 5 programs).
10. Social connections and responsibilities.
11. Plantation and adoption of plants. Know your plants.
12. Organize National integration and social harmony events /workshops/ seminars. (Minimum 02 programs).
13. Govt. school Rejuvenation and helping them to achieve good infrastructure.

NOTE:

1. Student/s in individual or in a group Should select any one activity in the beginning of each semester till end of that respective semester for successful completion as per the instructions of NSS officer with the consent of HOD of the department.

At the end of every semester, activity report should be submitted for evaluation.

Distribution of Activities –Semester wise from 3rd to 6th semester

Sem	Topics/Activities to be Covered
3rdSem for25 Marks	1. Organic farming, Indian Agriculture (Past, Present, and Future) Connectivity for marketing. 2. Waste management–Public, Private and Govt organization,5R's. 3. Setting of the information imparting club for women leading to contribution in social and economic issues.
4thSem for25 Marks	1. Water conservation techniques –Role of different stake holders–Implementation. 2. Preparing an actionable business proposal for enhancing the village income and approach for implementation. 3. Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/vocational education.
5thSem for25 Marks	1. Developing Sustainable Water management systems for rural areas and implementation approaches. 2. Contribution to any national-level initiative of the Government of India. For eg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc. 3. Spreading public awareness under rural outreach programs. (minimum 5programs). 4. Social connect and responsibilities.
6thSem for25 Marks	1. Plantation and adoption of plants. Know your plants. 2. Organize National integration and social harmony events /workshops /seminars. (Minimum 02 programs). 3. Govt.school Rejuvenation and helping them to achieve good infrastructure.

Course outcomes:

At the end of the course, the student will be able to:

COs	Description
M23BNSK410.1	Understand the importance of his /her responsibilities towards society.
M23BNSK410.2	Analyse the environmental and societal problems/issues and will be able to design solutions for the same.
M23BNSK410.3	Evaluate the existing system and to propose practical solutions for the same for sustainable development.
M23BNSK410.4	Implement government or self-driven projects effectively in the field.
M23BNSK410.5	Develop capacity to meet emergencies and natural disasters & practice national integration and social harmony in general.

Pedagogy–Guidelines:

It may differ depending on local resources available for the study as well as environment and climatic differences, location, and time of execution.

Sl No	Topic	Group size	Location	Activity execution	Reporting	Evaluation Of the Topic
1.	Organic farming, Indian Agriculture (Past, Present, and Future) Connectivity for marketing.	May be individual or team	Farmers land/ Villages/ roadside/ community area /College campus etc	Site selection / proper consultation/ Continuous monitoring/ Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
2.	Waste management–Public, Private and Govt organization, 5 R's.	May be individual or team	Villages/City Areas / Grama panchayat/public associations/ Government Schemes officers/ campus etc…	Site selection / proper consultation/ Continuous monitoring/ Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
3.	Setting of the information imparting club for women leading to contribution in social and economic issues.	May be individual or team	Women empowerment groups/ Consulting NGOs &Govt Teams /College campus etc…	Group selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
4.	Water conservation techniques – Role of different stakeholders– Implementation.	May be individual or team	Villages/City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus etc…	Site selection / Proper consultation/ Continuous monitoring/ Information board	Report should be submitted by an individual To the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer

5.	Preparing an actionable business proposal for enhancing the village income and approach for implementation.	May be individual or team	Villages City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus etc…	Group selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
6.	Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/ vocational education.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	School selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
7.	Developing Sustainable Water management system for rural areas and implementation approaches.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Site selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
8.	Contribution to any national-level initiative of the Government of India. For eg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc.	May be individual or team	Villages/City Areas / Grama panchayat/ public associations/ Government Schemes officers /campus etc…	Group selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
9.	Spreading public awareness under rural outreach programs.(minimum5 programs). ///// Social connect and responsibilities.	May be individual or team	Villages/City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus etc…	Group selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
10.	Plantation and adoption of plants. Know your plants.	May be individual or team	Villages/City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Place selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer

11.	Organize National integration and social harmony events /workshops /seminars. (Minimum 02 programs).	May be individual or team	Villages/City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Place selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
12.	Govt. school Rejuvenation and helping them to achieve good infrastructure.	May be an individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / Campus etc…	Place selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer

Plan of Action ((Execution of Activities for Each Semester)

Sl. No	Practice Session Description
1.	Lecture session by NSS Officer
2.	Students' Presentation on Topics
3.	Presentation- 1,Selection of topic,PHASE-1
4.	Commencement of activity and its progress-PHASE- 2
5.	Execution of Activity
6.	Execution of Activity
7.	Execution of Activity
8.	Execution of Activity
9.	Execution of Activity
10.	Case study-based Assessment, Individual performance
11.	Sector wise study and its consolidation
12.	Video-basedseminarfor10minutes by each student At the end of the semester with a Report.

- In every semester from 3rd semester to 6th semester, each student should do activities according to the scheme and syllabus.
- At the end of every semester student performance has to be evaluated by the NSS officer for the assigned activity progress and its completion.
- At last in 6th semester consolidated report of all activities from 3rd to 6th semester, compiled report should be submitted as per the instructions.

Assessment Details:

Weightage	**CIE–100%**	
Presentation -1 Selection of topic, PHASE-1	10 Marks	• Implementation strategies of the project(NSS work) • The last Report should be signed by the NSS Officer ,the HOD, and the principal. • At last Report should be evaluated by the NSS officer of the institute. • Finally, the consolidated marks sheet should be sent to the university and made available at the LIC visit.
Commencement of activity and its progress-PHASE-2	10 Marks	
Case Study-based Assessment Individual Performance with Report	10 Marks	
Sector-wise study & its consolidation	10 Marks	
Videobasedseminarfor10minutesbyeachstudentAttheendofsemesterwithReport.Activities.	10 Marks	
Total marks for the course in each semester	50 Marks	

Marks scored for 50 by the students should be Scale down to 25 marks In each semester for CIE entry in the VTU portal.
25 marks CIE entry will be entered in University IA marks portal at the end of each semester 3rd to 6th semester, Report and assessment copy should be made available in the department semester wise
Students should present the progress of the activities as per the schedule in the prescribed practical session in the field. There should be positive progress in the vertical order for the benefit of society in general.

Suggested Learning Resources:

Books:

1. NSS Course Manual, Published by NSS Cell, VTU Belagavi.
2. Government of Karnataka, NSS cell, activities reports and manual.
3. Government of India, NSS cell, Activities reports and manual.

5th Semester	Non Credit Mandatory Course (NCMC) PHYSICAL EDUCATION	M23BPEK509

PHYSICAL EDUCATION(SPORTS & ATHLETICS) (M23BPEK509)

SEMESTER-V

Course Outcomes: At the end of the course, the student will be able to CO1:
Understand the ethics and moral values in sports and athletics.
CO2: Perform in the selected sports or athletics of the student's choice.
CO3: Understand the roles and responsibilities of organization and administration of sports and games.

Module-1

Ethics and Moral Values (5hours)
Ethics in Sports
Moral Values in Sports and Games

Module-2

Specific Games (Any one to be selected by the student) (20 hours) Volleyball—Attack, Block, Service, Upper Hand Pass and Lower Hand Pass.
Throwball—Service, Receive, Spinattack, NetDrop & Jumpthrow.
Kabaddi—Hand touch, Toe Touch, Thigh Hold, Ankle hold and Bonus.
Kho-Kho— Giving Kho ,Single Chain, Pole dive, Pole turning,3-6Up.
Table Tennis—Service(Fore Hand & Back Hand),Receive(Fore Hand & Back Hand),Smash.
Athletics(Track/Field Events)—Any event as per availability of Ground.

Module-3

Role of Organisation and administration (5 hours)

Scheme and Assessment for auditing the course and Grades:

Sl. No.	Activity	Marks
1.	Participation of student in all the modules	**20**
2.	Quizzes—2,eachof15 marks	**30**
3.	Final presentation/exhibition /Participation in competitions/practical on specific tasks assigned to the students	**50**
Total		**100**

5th Semester	Non Credit Mandatory Course (NCMC) YOGA	M23BYOK509

Yoga			
Course Code	**M23BYOK509**		
Number of Lecture Hours/Week(L:T:P:S)	**0:0:2:0**	CIE Marks	**100**
Total Number of Lecture Hours		SEE Marks	**-**
Credits	**0**	Total Marks	**100**
Evaluation Method: Objective type Theory/Practical/Viva-Voce			

Course objectives:

1. To enable the student to have good Health.
2. To practice mental hygiene.
3. To possess emotional stability.
4. To integrate moral values.
5. To attain a higher level of consciousness.

The Health Benefits of Yoga

The benefits of various yoga techniques have been supposed to improve

- Body flexibility,
- performance,
- stress reduction,
- attainment of inner peace, and
- self-realization.

The system has been advocated as a complementary treatment to aid the healing of several ailments such as

- coronary heart disease,
- depression,
- anxiety disorders,
- asthma, and
- Extensive rehabilitation for disorders including musculoskeletal problems and traumatic brain injury.

The system has also been suggested as behavioral therapy for smoking cessation and substance abuse (including alcohol abuse).

If you practice yoga, you may receive these physical, mental, and spiritual benefits:

- Physical
  1. Improved body flexibility and balance
  2. Improved cardiovascular endurance (stronger heart)
  3. Improved digestion
  4. Improved abdominal strength
  5. Enhanced overall muscular strength
  6. Relaxation of muscular strains
  7. Weight control
  8. Increased energy levels
  9. Enhanced immune system
- Mental
  1. Relief of stress resulting from the control of emotions
  2. Prevention and relief from stress-related disorders
  3. Intellectual enhancement, leading to improved decision-making skills
- Spiritual
  1. Life with meaning, purpose, and direction
  2. Inner peace and tranquility
- Contentment

YOGA Syllabus

Semester IV

- Patanjali's Ashtanga Yoga, its need and importance.
- Yama: Ahimsa, satya, asteya, brahmacarya, aparigraha.
- Niyama: shoucha, santosh, tapa, svaadhyaya, Eshvarapranidhan
- Suryanamaskar12count-4roundsofpractice

- Asana, Need, importance of Asana. Different types of asana. Asana its meaning by name, technique, precautionary measures and benefits of each asana.
- Different types of Asanas

1. Sitting
   - Sukhasana
   - Paschimottanasana
2. Standing
   - Ardhakati Chakrasana
   - Parshva Chakrasana
3. Prone line
   - Dhanurasana
4. Supine line
   - Halasana
   - Karna Peedasana
   - Meaning, importance and benefits of Kapalabhati.
   - 40strokes/min3rounds
   - Meaning, Need, importance of Pranayama. Different types. Meaning by name, technique, precautionary measures and benefits of each Pranayama.
   - Pranayama

1. Suryanuloma–Viloma
2. Chandranuloma-Viloma
3. Suryabhedana
4. ChandraBhedana
5. Nadishodhana

Course out comes:

At the end of the course, the student will be able to:

- Understand the meaning, aim and objectives of Yoga.
- Perform Suryanamaskar and able to Teach its benefits.
- Understand and teach different Asanas by name, its importance, methods and benefits.
- Instruct Kapalabhati and its need and importance.
- Teach different types of Pranayama by their names, precautions, procedure and uses
- Coach different types of Kriyas, method to follow and usefulness. **Assessment Details (both CIE and SEE)**
- Students will be assessed with internal test by a. Multiple choice questions b. Descriptive type questions (Two internal assessment tests with 25 marks/test).
- Final test shall be conducted for whole syllabus for 50 marks. Continuous Internal Evaluation shall be for 100 marks (including IA test) **Suggested Learning Resources:**

Books:

1. Yogapravesha in Kannada by Ajitkumar
2. Light on Yoga by BKS Iyengar
3. Teaching Methods for Yogic practices by Dr.ML Gharote & Dr.SK Ganguly
4. Yoga Instructor Course handbook published by SVYASA University, Bengaluru
5. Yoga for Children–step by step –by Yamini Muthanna **Web links and Video Lectures (e-Resources): Refer links** https://youtu.be/KB-TYlgd1wE https://youtu.be/aa-TG0Wg1Ls

6th Semester	Integrated Professional Course (IPC) DIGITAL SIGNAL PROCESSING	M23BEC601

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Mathematics	Understanding of solving matrix, trigonometric functions, linear and quadratic equations. Proficiency in differential and integral calculus, including applications. Familiarity with Fourier representations, Laplace and Z transform, and their properties.
2	Signals and Systems	Grasp Basics of different types of signals and its operations. Systems and its properties. Fourier representation of Signals.
3	Basic Electronics	Basic concepts of filters and its design, analog and digital electronics.

2. Competencies

S/L	Competency	KSA Description
1	Mastery of Discrete Fourier Transforms (DFT)	**Knowledge:** Understanding DFT principles and their properties. **Skill:** Ability to apply DFT for signal analysis and processing. **Attitude:** Precision in mathematical transformations and curiosity in exploring DFT applications
2	Expertise in Linear Filtering and Advanced DFT Applications	**Knowledge:** Familiarity with linear filtering methods and advanced DFT algorithms. **Skill:** Capability to design and implement efficient linear filters using DFT. **Attitude:** Analytical mindset with a focus on optimizing filtering techniques.
3	Proficiency in Radix-2 FFT Algorithms	**Knowledge:** Thorough understanding of Radix-2 FFT and its computational benefits. **Skill:** Proficiency in implementing and optimizing FFT algorithms. **Attitude:** Commitment to efficiency in algorithm design and implementation.
4	FIR Filter Design and Implementation	**Knowledge:** Understanding of FIR filter properties and design techniques. **Skill:** Ability to design and implement FIR filters using various window functions. **Attitude:** Attention to detail and creativity in filter design..
5	IIR Filter Design and Realization	**Knowledge:** Deep understanding of IIR filter design techniques and analog transformations. **Skill:** Competence in designing and realizing IIR filters for specific applications. **Attitude:** Precision in applying advanced techniques and commitment to filter stability.

6	Digital Signal Processor Architecture	**Knowledge:** DSP hardware architectures and formats.. **Skill:** Work with DSP units and apply them to real-world problems. **Attitude:** Enthusiasm for hardware and software integration.

3. Syllabus

DIGITAL SIGNAL PROCESSING SEMESTER – VI			
Course Code	**M23BEC601**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**3:0:2:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory +10 lab slots**	Total Marks	**100**
Credits	**04**	Exam Hours	**03**

Course Objectives:

1. To, learn the basics of DSP, its properties and related transforms effectively.
2. Determine the response of LTI systems using time domain and DFT techniques.
3. Compute DFT of real and complex discrete time signals.
4. Compute DFT using FFT algorithms.
5. Design FIR and IIR Filters and implement their structure.

Module -1

Discrete Fourier Transforms (DFT): Frequency domain sampling and Reconstruction of Discrete Time Signals, The Discrete Fourier Transform, DFT as a linear transformation, Properties of the DFT: Periodicity, Linearity and Symmetry properties, Multiplication of two DFTs and Circular Convolution.

Module -2

Additional DFT Properties, Linear filtering methods based on the DFT: Use of DFT in Linear Filtering, Filtering of Long Data Sequences. Fast-Fourier-Transform (FFT) algorithms: Efficient Computation of the DFT: Radix-2 FFT algorithms for the computation of DFT and IDFT decimation in time.

Module -3

Design of FIR Filters: Characteristics of practical frequency-selective filters, Symmetric and Anti-symmetric FIR filters, Design of Linear-phase FIR (low pass and High pass) filters using windows - Rectangular, Hamming, Hanning, Bartlett windows. Structure for FIR Systems: Direct form, Cascade form and Lattice structures.

Module -4

IIR Filter Design: Infinite Impulse Response Filter Format, Bilinear Transformation Design Method, Analog Filters using Low pass prototype transformation, Normalized Butterworth Functions, Bilinear Transformation and Frequency Warping, Bilinear Transformation Design Procedure, Digital Butterworth (Low pass and High pass) Filter Design using BLT. Realization of IIR Filters in Direct form I and I.

Module -5

Digital Signal Processors: DSP Architecture, DSP Hardware Units, fixed point format, Floating point Format, IEEE Floating point formats, Fixed point digital signal processors, FIR and IIR filter Implementations in Fixed point systems.

PRACTICAL COMPONENT OF IPCC

List of Programs to be implemented & executed using any programming languages like C++/Python/Java/Scilab / MATLAB/Octave/CC Studio (but not limited to)

1. Computation of N point DFT of a given sequence and to plot magnitude and phase spectrum.
3. Computation of linear convolution of two sequences using DFT and IDFT.
4. Verification of Linearity property, Parseval's theorem ,circular time shift property & circular frequency shift property of DFT.
5. Design and implementation of IIR (Butterworth) low pass filter to meet given specifications.
6. Design and implementation of IIR (Butterworth) high pass filter to meet given specifications.
7. Design and implementation of low pass FIR filter to meet given specifications.
8. Design and implementation of high pass FIR filter to meet given specifications.
9. Compute the N- Point DFT of a given sequence using DSK 6713 simulator.
10. Compute the linear convolution of two given sequences using the DSK 6713 simulator.
11. Compute the circular convolution of two given sequences using the DSK 6713 simulator.

TEXTBOOKS:

1. Proakis & Manolakis, "Digital Signal Processing - Principles Algorithms & Applications", 4th Edition, Pearson Education, New Delhi, 2007. ISBN: 81-317-1000-9.
2. Li Tan, Jean Jiang, "Digital Signal Processing - Fundamentals and Applications", Academic Press, 2013, ISBN: 978-0-12-415893.

REFERENCE BOOKS:

2. Sanjit K Mitra, "Digital Signal Processing, A Computer Based Approach", 4th Edition, McGraw Hill Education, 2013.
3. Oppenheim & Schaffer, "Discrete Time Signal Processing", PHI, 2003.
4. D Ganesh Rao and Vineeth P Gejji, "Digital Signal Processing" Cengage India Private Limited,2017, ISBN: 9386858231.
5. Vinay K. Ingle and John G. Proakis, "Digital Signal Processing Using MATLAB: A Problem Solving Companion".

6. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-3: Discrete Fourier Transforms (DFT)	Understanding Frequency domain sampling and Reconstruction of Discrete Time Signals, Definition of DFT and IDFT, computation of DFT using formula and matrix method, Concept of twiddle factor, relationship with other transforms, properties of DFT
2	Week 4-6: Linear filtering methods based on the DFT	Additional DFT properties, Response of LTI systems using time domain and / or frequency domain for small and large duration sequences, Direct computation of DFT.
3	Week 7-8: Design of FIR Filters	Design of FIR Filters: Properties of FIR digital filters, different types of windows - Rectangular, Hanning, Hamming, design of FIR filters using above windows. Realization of FIR Filter structures**:** Direct form, Cascade form and Lattice structures
4	Week 9-10: IIR Filter Design	Frequency transformations in the analog domain, characteristics of commonly used analog filters, IIR filter design by Bilinear transformation technique, application of above technique to the design of Butterworth, realization of IIR Filter structures: Direct form I and II realizations.
5	Week 11-12: Digital Signal Processors:	Understanding DSP Architecture, key hardware components, difference between Fixed point format and Floating point Format, IEEE Floating point formats, Fixed point digital signal processors, FIR and IIR filter implementations in Fixed point systems.

6. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description

1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance the understanding of processing the digital signals.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with real world competencies.
5	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
6	Laboratory Learning	Utilize the facilities available in the laboratories to understand the usage of MATLAB tools and inbuilt commands by performing few experiments.

6. Assessment Details (both CIE and SEE) Continuous Internal Evaluation:

The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up

Components		**Number**	**Weightage**	**Max. Marks**	**Min. Marks**
Theory(A)	Internal Assessment-Tests (A)	2	60%	15	06
	Assignments/Quiz/Activity	2	40%	10	04
	(B) Total Marks		100%	25	10
Components		**Number**	**Weightage**	**Max. Marks**	**Min. Marks**
Laboratory(B)	Record Writing	Continuous	60%	15	06
	Test at the end of the semester	1	40%	10	04
	Total Marks		100%	**25**	**10**

Final CIE Marks =(A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

1. Question paper pattern will be ten questions. Each question is set for 20 marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks.

7. Learning Objectives

S/L	Learning Objectives	Description
1	DFT and IDFT	grasp the theoretical foundations of DFT, including its properties like periodicity, linearity, and symmetry, and will learn to apply DFT for signal analysis and reconstruction in various contexts
2	Linear filtering methods	To use of DFT for designing and implementing linear filters, including techniques like the Goertzel algorithm and Chirp Z-Transform, and will understand their applications in filtering long data sequences.
3	FFT Technique	Develop the ability to efficiently compute DFTs using Radix-2 FFT algorithms, understanding decimation-in-time and decimation-in-frequency techniques, and apply these skills to real-time signal processing tasks.
4	FIR filter Design	Designing FIR filters using various window functions, such as Rectangular, Hanning, and Hamming, and learn to implement these designs in different FIR filter structures.
5	IIR filter Design	Design IIR filters using methods like impulse invariance and bilinear transformation, and will understand how to apply these techniques to create practical filters, such as Butterworth filter, for specific applications.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC601.1	**Apply** the fundamental mathematics to change domain of the signals and prove their properties.
M23BEC601.2	**Apply** DFT concepts to compute the response of LTI systems and FFT algorithm to compute DFT.
M23BEC601.3	**Analyze** the given transfer function to design and realize FIR and IIR filters**.**
M23BEC601.4	**Present** the comprehension of the architectural features, working of digital signal processor.
M23BEC601.5	**Simulate** the experiments either individually or in team using MATLAB and CC Studio Tools.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC601.1	3	3	-	-	2	-	-	-	-	-	-	-	3	-
M23BEC601.2	3	3	-	-	2	-	-	-	-	-	-	-	3	-
M23BEC601.3	3	3	3	-	2	-	-	-	-	-	-	-	3	-
M23BEC601.4	3	-	-	-	-	-	-	-	-	-	-	-	2	-
M23BEC601.5	-	-	-	-	3	-	-	-	3	-	-	-	-	-
M23BEC601	**3**	**3**	3	**-**	2.25	**-**	**-**	**-**	3	**-**	**-**	**-**	2.75	**-**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**8**					**8**
Module 2		**7**		**2**	**2**	**11**
Module 3		**7**		**2**	**2**	**11**
Module 4			**6**	**2**	**2**	**10**
Module 5			**6**	**2**	**2**	**10**
Total	**8**	**14**	**12**	**8**	**8**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**16**					**16**
Module 2		**14**		**4**	**4**	**22**
Module 3		**14**		**4**	**4**	**22**
Module 4			**12**	**4**	**4**	**20**
Module 5			**12**	**4**	**4**	**20**
Total	**16**	**28**	**24**	**16**	**16**	**100**

10. Future with this Subject:

- **Advanced Communications:** Expertise in DSP is crucial for the development of advanced communication systems like 5G, satellite communications, and even quantum communication systems.
- **Machine Learning and AI:** DSP techniques are increasingly used in feature extraction, data preprocessing, and enhancing the performance of AI models, especially in audio, image, and video data.
- **Healthcare Technologies:** Digital signal processing is essential in modern healthcare devices, from imaging systems to portable diagnostic devices. Your knowledge will be valuable in the growing field of digital health.
- **Autonomous Systems:** The ability to design and implement efficient DSP algorithms will be critical in the development of autonomous vehicles, drones, and robots, all of which rely heavily on realtime signal processing

6th Semester	Professional Course (PC) CMOS VLSI DESIGN	M23BEC602

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Semiconductor Physics	Basic knowledge of different semiconductor materials and their behaviors under various conditions. Fundamental concepts of voltage, current, and power.
2	Mathematics	Understanding of solving linear and quadratic equations Familiarity with differential and integral calculus.
3	Basic Electrical Engineering	Grasp of network theorems and laws.
4	Analog Electronics	Basic concepts of circuit elements and design. Operational knowledge of transistors and different regions of operation. Principles of small-signal and large-signal analysis.
5	Digital Electronics	Basic concepts of minimization techniques. Principles of digital circuits and logic families.

2. Competencies

S/L	Competency	KSA Description
1	Design and Analysis of MOS Transistors	**Knowledge:** Fundamental operations and I-V characteristics of MOSFETs. **Skills:** Analyzing and modeling MOSFETs in different configurations. **Attitudes:** Critical thinking in the application of MOS theory.
2	CMOS Fabrication Techniques	**Knowledge:** CMOS process technology and its implications for design. **Skills:** Developing layouts and understanding the impact of design rules. **Attitudes:** Precision and thoroughness in fabrication and design processes.
3	Dynamic Logic Design and Optimization	**Knowledge:** Pass transistor logic, dynamic circuit techniques. **Skills:** Designing dynamic CMOS circuits for high-speed applications. **Attitudes:** Innovation and adaptability in design optimization.
4	CMOS Analog Circuit Design	**Knowledge:** Small-signal modelling and amplifier design. **Skills:** Implementing analog circuits with a focus on performance metrics. **Attitudes:** Creative problem-solving in analog design challenges.
5	CMOS Memory Circuits	**Knowledge:** Operation of different memory types (DRAM, SRAM, Flash). **Skills:** Analysis of various memory circuits. **Attitudes:** Precision and innovation in memory technology.

3. Syllabus

CMOS VLSI DESIGN SEMESTER – VI			
Course Code	**M23BEC602**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**4:0:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**50 hours**	Total Marks	**100**
Credits	**04**	Exam Hours	**03**

Course Objectives:

1. Understanding the fundamental principles of MOS transistor theory and its applications in CMOS VLSI design.
2. Understand CMOS fabrication technologies and their impact on circuit layout and performance.
3. Develop dynamic logic circuits and explore advanced circuit design techniques for high-performance systems.
4. Apply principles of CMOS analog circuit design to develop small-signal models and single-stage amplifiers.
5. Understand semiconductor memory circuits, including DRAM, SRAM, and non-volatile memory technologies Get familiar with computer programs that help with stress analysis and design.

Module -1

MOS Transistor Theory: VLSI Design Flow, Device Structure and Physical Operation, Current-Voltage Characteristics, DC Transfer Characteristics, MOSFET Circuits design at DC.

Module -2

Fabrication: CMOS Fabrication and Layout, Introduction, CMOS Technologies, Layout Design Rules, (Text3: **1.5, 3.1 and 3.2**)

Delay: Introduction, Transient Response, RC Delay Model, Linear Delay Model, Logical Efforts of Paths

Module -3
Dynamic Logic Circuits: Introduction, Basic Principles of Pass Transistor Circuits, Voltage Bootstrapping, Synchronous Dynamic Circuit Design Techniques, Dynamic CMOS Circuit Design Techniques, High–Performance Dynamic CMOS Circuits
Module -4
CMOS Analog Circuits: Small-signal Equivalent-circuit models, The transconductance g_m, The T Equivalent-circuit model, Single-stage MOS Amplifiers The Basic MOSFET Current Source, MOS Current-Steering Circuits
Module -5
Semiconductor Memories: Introduction, Dynamic Random Access Memory (DRAM) and Static Random Access Memory (SRAM), Non-volatile Memory, Flash Memory, Ferroelectric Random Access Memory (FRAM)
TEXTBOOKS: 1. "CMOS Digital Integrated Circuits Analysis and Design", Sung – Mo Kang, Yusuf Leblebici, 3rd edition, McGraw Hill Education 2003, ISBN-13:978-0-07-053077-5, ISBN-10:0-07-053077-7. 2. "Microelectronic Circuits Theory and Applications", Adel S. Sedra, Kenneth C. Smith, Fifth Edition International Version, Oxford University Press **REFERENCE BOOKS:** 1. "CMOS VLSI Design- A Circuits and Systems Perspective", Neil H E Weste, and David Money Harris 4th Edition, Pearson Education. 2. "Basic VLSI Design", Douglas A Pucknell, Kamran Eshraghian, 3rd Edition, Prentice Hall of Indiapublication, 2005. **VIDEO LINKS:** 1. https://www.youtube.com/watch?v=faiEVOOCes&list=PLLy_2iUCG87Bdulp9brz9AcvW_TnFCUmM&index=2

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: MOS Transistor Theory	• Overview of MOS transistor structure and operation. • Explore the VLSI design flow and analyze MOSFET I-V characteristics.
2	Week 3-4: DC Characteristics and Circuit Design	• Detailed study of DC transfer characteristics and MOSFET circuits at DC. • Apply principles to design simple MOSFET circuits.
3	Week 5-6: CMOS Fabrication and Layout	• Introduction to CMOS fabrication technologies and layout design rules. • Understand the impact of layout on circuit performance.
4	Week 7: Delay Analysis in CMOS Circuits	• Explore transient response, RC delay model, and linear delay models. • Analyze logical efforts in circuit paths and optimize delay.
5	Week 8-9: Dynamic Logic Circuits	• Study principles of pass transistor circuits and dynamic CMOS circuits. • Implement synchronous and high-performance dynamic circuit techniques.
6	Week 10-11: CMOS Analog Circuits	• Develop small-signal equivalent models and single-stage MOS amplifiers. • Design and analyze MOSFET current sources and currentsteering circuits.
7	Week 11: Semiconductor Memory Circuits	• Explore DRAM, SRAM, and non-volatile memory architectures. • Understand the operation and design of Flash and FRAM.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description

1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of Verilog concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with realworld competencies.
5	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies

6. Assessment Details (both CIE and SEE) Continuous Internal Evaluation:

The minimum CIE marks requirement is 40% of the maximum marks in each component.

CIE Split up

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks =(A) + (B)

The average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

1. Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC602.1	3	2	-	-	-	-	-	-	-	-	-	-	3	3
M23BEC602.2	3	-	-	-	-	-	-	-	-	-	-	-	3	3
M23BEC602.3	3	-	-	-	-	-	-	-	-	-	-	-	3	3
M23BEC602.4	-	3	-	-	-	-	-	-	-	-	-	-	3	3

M23BEC602.5	-	3	-	-	-	-	-	-	-	-	-	-	3	3
M23BEC602	**3**	**2.6**	-	-	-	-	-	-	-	-	-	-	**3**	**3**

4. Marks scored will be proportionally scaled down to 50 marks **7. Learning Objectives**

S/L	Learning Objectives	Description
1	Analyze MOS Transistor Characteristics	Understand and analyze the I-V characteristics and DC behavior of MOS transistors. Apply this knowledge to design basic MOS circuits.
2	Design CMOS Layouts and Analyse Delays	Design CMOS layouts following fabrication rules and analyze delays using RC and linear delay models. Optimize designs for speed and efficiency.
3	Implement Dynamic Logic Circuits	Develop dynamic CMOS circuits using pass transistor and voltage bootstrapping techniques. Analyze their performance for high-speed applications.
4	Design CMOS Analog Circuits	Create small-signal MOS amplifiers and current sources. Apply small-signal models to analyze circuit behavior.
5	Analyze Semiconductor Memory Circuits	Understand the architecture and operation of various semiconductor memories. Design and evaluate DRAM, SRAM, and non-volatile memories.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC602.1	Describe the principles of MOS transistors, CMOS logic, and CMOS fabrication and layout, including the processes and design rules that underpin integrated circuit design.
M23BEC602.2	Apply the knowledge of CMOS layout and design rules to develop digital CMOS circuits.
M23BEC602.3	Apply the knowledge of CMOS circuits and CMOS circuit models to determine various circuit parameters.
M23BEC602.4	Analyze the electrical characteristics of MOS transistors and CMOS circuits, to know their impact on circuit performance, including transient response, delay models, and logical efforts of paths.
M23BEC602.5	Analyze different types of semiconductor memories (DRAM, SRAM, flash, FRAM).

CO-PO-PSO Mapping

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**3**		**3**	**4**		**10**
Module 2	**3**	**5**	**3**			**11**
Module 3	**4**			**6**		**10**
Module 4			**4**	**5**		**09**
Module 5					**10**	**10**
Total	**10**	**5**	**10**	**15**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	Total

Module 1	**6**		**6**	**8**		**20**
Module 2	**8**	**5**	**7**			**20**
Module 3	**8**			**12**		**20**
Module 4			**8**	**12**		**20**
Module 5					**20**	**20**
Total	**22**	**5**	**21**	**32**	**20**	**100**

10. Future with this Subject

The CMOS VLSI Design course equips students with the foundational and advanced knowledge required to excel in semiconductor design and related fields. It serves as a critical stepping stone for courses in digital and analog IC design, microelectronics, and embedded systems. Students will gain the skills necessary to contribute to the development of cutting-edge technologies in VLSI, enhancing their expertise in circuit design, fabrication, and optimization. The course's emphasis on research and innovation prepares students for advanced studies or careers in semiconductor industries and research labs.

6th Semester	Professional Elective Course -II (PE) MACHINE LEARNING	M23BEC603A

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Mathematics and Statistics	• • Understanding of solving calculus, linear algebra, probabilities, and statistics Understanding of vectors, matrices, and their operations. Concepts like matrix multiplication, Eigen values, and singular value decomposition are • important. Basic concepts such as probability distributions, mean, variance, standard deviation, and statistical inference are important for understanding data and making predictions. • Knowledge of derivatives and integrals, particularly partial derivatives, is useful. This helps in understanding optimization algorithms and how machine learning models are trained.
2	Data Analysis	• Skills in manipulating and cleaning data using libraries such as Pandas. • Ability to visualize data using tools like Matplotlib or Seaborn helps understand the data better and communicate results.
3	ANN	• Familiarity with neural network architectures, such as feed forward and convolution neural networks.
4	Programming Skills	• Python: The most commonly used language in machine learning due to its rich ecosystem of libraries and frameworks. Libraries like NumPy, Pandas, Scikit-learn, Tensor Flow, and PyTorch are essential. • Basic Algorithms and Data Structures: Understanding basic data structures (like lists, dictionaries, and arrays) and algorithms (like sorting and searching) help implement machine learning algorithms efficiently.
5	Tools and Frameworks	• Integrated Development Environments (IDEs): Familiarity with tools like Jupyter Notebook or PyCharm can enhance productivity.

2. Competencies

S/L	Competency	KSA Description
1	Understanding basics Machine learning	**Knowledge:** Students should be able to identify, define, and explain fundamental ML such as supervised, unsupervised, and deep learning algorithms. **Skills:** Designing, analyzing, and evaluating the performance of ML algorithms in Python. **Attitudes:** Attention to detail in data analysis and calculations. Persistence in solving complex data problems and verifying results
2	Data Handling	**Knowledge:** Techniques to handle missing data, outliers, and inconsistencies. **Skills:** Creating meaningful features from raw data. **Attitudes:** Normalization, scaling, encoding categorical variables.
3	Mathematics and Statistics	**Knowledge:** Understanding vectors, matrices, and operations on them. **Skills:** Particularly differential calculus for optimization algorithms. **Attitudes:** Essential for understanding models, data distributions, and making predictions.

4	Practical Problem Solving	**Knowledge:** Solving a variety of problems using ML models and algorithms through programming assignments, and problem-solving sessions. **Skills:** We are developing the ability to critically analyze problem scenarios and choose the most appropriate data models and algorithms to solve them efficiently. **Attitudes:**

		Willingness to tackle challenging problems and persevere until solutions are found.

3. Syllabus

MACHINE LEARNING SEMESTER – VI			
Course Code	**M23BEC603A**	CIE Marks	**50**
Number of Lecture Hours/Week (L: T: P: S)	**3:0:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course Objectives:

1. To understand the problems in machine learning
2. To understand supervised, unsupervised, or reinforcement learning for problem-solving.
3. To gain knowledge about probability and statistics in machine learning
4. To create new machine learning techniques to implement in real time applications.

Module -1

Introduction to Machine Learning: Need for Machine Learning, ML about other fields, types of ML, Challenges of ML, ML Process, ML applications

Understanding Data: What is data? Types of Data, Big data analytics and types of analytics, Descriptive Statistics, Univariate Data analysis and visualisation, Bivariate and multivariate data, Multivariate statistics

Module -2

Basics of Learning Theory: Introduction: Well-posed learning problems, Designing a Learning system, Perspective and Issues in Machine Learning.

Concept Learning: Concept learning task, Concept learning as search, Find-S algorithm, Version space, Candidate Elimination algorithm, Inductive Bias.

Module -3

Decision Tree Learning: Decision tree representation, Appropriate problems for decision tree learning, Basic decision tree learning algorithm, hypothesis space search in decision tree learning, Inductive bias in decision tree learning, Issues in decision tree learning.

Module -4

Bayesian Learning: Introduction, Bayes theorem, Bayes theorem and concept learning, ML and LS error hypothesis, ML for predicting probabilities, MDL principle, Naive Bayes classifier, Bayesian belief networks, EM algorithm

Module -5

Evaluating Hypothesis: Motivation, estimating hypothesis accuracy, Basics of sampling theorem, General approach for deriving confidence intervals, Difference in error of two hypotheses, Comparing learning algorithms.

Instance Based Learning: Introduction, k-nearest neighbor learning, locally weighted regression, radial basis function, cased-based reasoning,

Reinforcement Learning: Introduction, Learning Task, Q Learning

TEXTBOOKS:

1. S.Sridhar, M. Vijayalakshmi, Machine Learning, Oxford university press, 2023.
2. Tom M. Mitchell, Machine Learning, India Edition 2013, McGraw Hill Education.

REFERENCE BOOKS:

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, 2nd edition, springer series in statistics.
2. Ethem Alpaydın, Introduction to machine learning, second edition, MIT press.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description

1	Week 1-3: Introduction to ML, Understanding data	Need for Machine Learning, ML about other fields, types of ML, Challenges of ML, ML Process, ML applications What is data? Types of Data, Big data analytics and types of analytics, Descriptive Statistics, Univariate Data analysis and visualization, Bivariate and multivariate data, Multivariate statistics
2	Week 4-6: Basics of Learning Theory	Introduction: Well-posed learning problems, Designing a Learning system, Perspective, and Issues in Machine Learning. Concept learning task, Concept learning as search, Find-S algorithm, Version space, Candidate Elimination algorithm, Inductive Bias.
3	Week 8-11: Decision Tree Learning	Decision tree representation, Appropriate problems for decision tree learning, Basic decision tree learning algorithm, hypothesis space search in decision tree learning, Inductive bias in decision tree learning, Issues in decision tree learning.
4	Week 7-8: Bayesian Learning	Introduction, Bayes theorem, Bayes theorem and concept learning, ML and LS error hypothesis, ML for predicting probabilities, MDL principle, Naive Bayes classifier, Bayesian belief networks, EM algorithm
5	Week 9-12: Evaluating Hypothesis	Motivation, estimating hypothesis accuracy, Basics of sampling theorem, General approach for deriving confidence intervals, Difference in error of two hypotheses, Comparing learning algorithms.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of Verilog concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with real world competencies.
5	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
6	Laboratory Learning	Utilize the facilities available in the laboratories to understand the behavior of the materials by performing few experiments.

6. Assessment Details (both CIE and SEE) Continuous Internal Evaluation:

The minimum CIE marks requirement is 40% of maximum marks in each component. **CIE Split up**

Components		Number	Weight age	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks =(A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

1. Question paper pattern will be ten questions. Each question is set for 20 marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Introduction to ML, and understanding of data	Learn the basic principles of machine learning, including supervised, unsupervised, and reinforcement learning.
2	Basics of Learning Theory	Study different types of algorithms like decision trees, support vector machines, neural networks, and clustering algorithms.
3	Decision Tree Learning	Learn what decision trees are and how they work, including their structure (nodes, branches, leaves) and how decisions are made. Understand how decision trees are built using algorithms that split data based on feature values to make predictions.
4	Bayesian Learning	Understand the core principles of Bayesian inference, including Bayes' Theorem, which provides a way to update the probability of a hypothesis based on new evidence. Learn about prior distributions and posterior distributions.
5	Evaluating hypothesis, Instance-Based Learning, Reinforcement Learning	Learn what constitutes a hypothesis in machine learning and how hypotheses are used to make predictions or decisions.
		Differentiate between different types of hypotheses, such as statistical models, machine learning models, and theoretical models. Understand metrics such as accuracy, precision, recall, F1 score, and ROC-AUC for evaluating classification hypotheses.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC603A.1	**Explain** fundamental concepts of data, basic learning theory and different learning algorithms
M23BEC603A.2	**Apply** the data pre-processing technique and perform exclamatory data analysis to prepare data for machine learning algorithms
M23BEC603A.3	**Compute** various parameters of Basic Learning theory. Decision Tree Learning , Bayesian Learning, Instance Based Learning, and Reinforcement Learning
M23BEC603A.4	**Analyze and interpret** the results of Machine Learning and classification methods

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC603A.1	3	3	3	-	-	-	-	-	-	-	-	-	2	--
M23BEC603A.2	3-	3	3	-	-	-	-	-	-	-	-	-	2	--
M23BEC603A.3	**3**	**3**	3	-	-	-	-	-	-	-	-	-	2	--
M23BEC603A.4	**3**	**3**	3	-	-	-	-	-	-	-	-	-	2	--
M23BEC603A	**3**	**3**	3										2	--

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	Total
Module 1	**10**			**10**
Module 2		**10**		**10**
Module 3		**10**		**10**
Module 4			**10**	**10**
Module 5			**10**	**10**

Total	**10**	**20**	**20**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	Total
Module 1	**20**			**20**
Module 2		**20**		**20**
Module 3		**20**		**20**
Module 4			**20**	**20**
Module 5			**20**	**20**
Total	**20**	**40**	**40**	**100**

10. Future with this Subject:

The future of machine learning holds exciting possibilities across various domains, driven by advancements in technology and expanding applications. Here are some key trends and potential developments in the future of machine learning.

- **Advanced Algorithms and Techniques**: Continued improvements in deep learning architectures, including more efficient models and techniques for better generalization and reduced computational requirements.
- **Reinforcement Learning**: Increased application of reinforcement learning for complex decision-making tasks, such as robotics, autonomous systems, and optimization problems.
- **Generative Models**: Expansion of generative models like Generative Adversarial Networks and Variation Auto encoders for creating realistic synthetic data, art, and simulations.
- **Integration with Other Technologies:** Use of ML algorithms in conjunction with IoT and block chain technology to enhance security, fraud detection, and decentralized applications.
- **Cross-Domain Applications:** Advances in ML applications for health care, finance, and climate change to address global challenges.

6th Semester	Professional Elective Course -II (PE) CYBER SECURITY	M23BEC603B

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basics of Mathematics	Basics of number theory, algebra, probability and statistics
2	Knowledge of algorithms	Knowledge of algorithms (like sorting and searching) and data structures (like arrays, linked lists, trees)
3	Basic Programming Skills	Programming languages like c, c++, python etc.,
4	Previous Coursework	Information theory and coding, Numerical methods

2. Competencies

S/L	Competency	KSA Description
1	Knowledge on Mathematics	**Knowledge:** Understanding the Number theory, algebraic structures, probability and statistics. **Skills:** Cryptographic algorithms foundations, elliptic curves, probabilistic methods. **Attitudes:** Randomness and statistical tests.
2	Familiarity on Cryptographic Algorithms	**Knowledge:** Symmetric and asymmetric encryption, hash functions and digital signatures **Skills:** Ability to analyse cryptographic systems. **Attitudes:** Utilize cryptographic primitives, ensuring CIA
3	Proficiency in Cryptographic protocols	**Knowledge:** Use of different methods in appropriate contexts. **Skills:** Hash functions, key management and Message authentication, **Attitudes:** Ability to use protocols in public key infrastructures.
4	Knowledge on cryptographic principles, regulations and Security	**Knowledge:** Understanding of threat modeling and standards of cryptography **Skills:** Familiarity on NIST, ISO/IEC. **Attitudes:** Testing the security of cryptosystems to identify and address vulnerabilities.
5	Proficiency in cryptanalysis	**Knowledge:** Ability to approach cryptographic challenges methodically. **Skills:** Familiarity on security assessments **Attitudes:** Ability to evaluate strengths and weakness of different cryptographic approaches.

3. Syllabus

CYBER SECURITY SEMESTER – VI			
Course Code	**M23BEC603B**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**3:0:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course Objectives:

1. Understand the knowledge of mathematical concepts required for cryptography. 2. Understand the basics of symmetric key and public key cryptography
3. Understand symmetric and asymmetric cryptography algorithms.
4. Describe the pseudo-random sequence generation technique.
5. Describe and explain post quantum cryptography algorithms.

Module -1

Classical Encryption Techniques: Symmetric cipher model, Substitution techniques, Transposition techniques Basic Concepts of Number Theory and Finite Fields: Euclidean algorithm, Modular arithmetic

Module -2

Symmetric ciphers: symmetric cipher model, cryptanalysis and brute force attack, substitution techniques Traditional Block Cipher structure, Data encryption standard (DES), The AES Cipher.

Module -3

Basic Concepts of Number Theory and Finite Fields: Groups, Rings and Fields, Finite fields of the form GF(p), Prime Numbers, Fermat's and Euler's theorem, discrete logarithm.

Module -4

Asymmetric ciphers: Principles of Public-Key Cryptosystems, The RSA algorithm, Diffie - Hellman Key Exchange, Elliptic Curve Arithmetic, Elliptic Curve Cryptography

Module -5

Pseudo-Random-Sequence Generators and Stream Ciphers: Linear Congruential Generators, Linear Feedback Shift Registers, Design and analysis of stream ciphers, Stream ciphers using LFSRs, A5, Hughes XPD/KPD, Additive generators, Gifford, Algorithm M,PKZIP

Post and Quantum Cryptography: Introduction to post and quantum cryptography, Shor's algorithm and BB84 protocol.

TEXT BOOKS:

1. William Stallings, "Cryptography and Network Security Principles and Practice", Pearson Education Inc., 6th Edition, 2014, ISBN: 978-93-325-1877-3
2. Bruce Schneier, "Applied Cryptography Protocols, Algorithms, and Source code in C", Wiley Publications, 2nd Edition, ISBN: 9971-51-348-X
3. Michael A. Nielsen, Isaac L. Chuang, Massachusetts Institute of Technology," Quantum Computation and Quantum Information", Cambridge University Press, ISBN: 9780511976667

REFERENCE BOOKS:

1. Cryptography and Network Security, Behrouz A. Forouzan, TMH, 2007.
2. Cryptography and Network Security, AtulKahate, TMH, 2003.
3. S. Pirandola, "Advances in Quantum Cryptography" https://doi.org/10.48550/arXiv.1906.01645

VIDEO LINKS:

1. https://archive.nptel.ac.in/courses/106/105/106105162/

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-3: Classical Encryption Techniques	Understand the basics of symmetric key and public key cryptography
2	Week 4-6: Symmetric ciphers	Describe and explain classical cryptography algorithms.
3	Week 8-11: Basic Concepts of Number Theory and Finite Fields	Acquire knowledge of mathematical concepts required for cryptography.
4	Week 7-8: Asymmetric ciphers	Describe pseudo random sequence generation technique.
5	Week 9-12:Pseudo-Random-Sequence Generators and Stream Ciphers	Explain symmetric and cryptography aalgorithms.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of Verilog concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with real world competencies.
5	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate a deeper understanding of competencies
6	Laboratory Learning	Utilize the facilities available in the laboratories to understand the behavior of the materials by performing a few experiments.

6. Assessment Details (both CIE and SEE) Continuous Internal Evaluation:

The minimum CIE marks requirement is 40% of the maximum marks in each component.

CIE Split up

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks =(A) + (B)

The average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

1. The question paper pattern will be ten questions. Each question is set for 20 marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 questions from each module, each of the two questions under a module (with a maximum of 3 sub-questions), may have a mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Knowledge on Mathematics	Understanding the Number theory, algebraic structures, probability, and statistics. Cryptographic algorithms foundations, elliptic curves, probabilistic methods. Randomness and statistical tests.
2	Familiarity on Cryptographic Algorithms	Symmetric and asymmetric encryption, hash functions, and digital signatures with the ability to analyze cryptographic systems by utilizing cryptographic primitives, ensuring CIA
3	Proficiency in Cryptographic protocols	Use of different methods in appropriate contexts. Hash functions, key management and Message authentication, and Ability to use protocols in public key infrastructures.
4	Knowledge on cryptographic principles, regulations and Security	Understanding of threat modeling and standards of cryptography, Familiarity with NIST ISO/IEC, Testing the security of cryptosystems to identify and address vulnerabilities.

5	Proficiency in cryptanalysis	Ability to approach complex cryptographic challenges methodically. Familiarity with security assessments, Critical thinking, and evaluating strengths and weaknesses of different cryptographic approaches.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC603B.1	**Explain the** concepts of cryptographic techniques using number theory, finite fields and advances in cryptography.
M23BEC603B.2	**Apply** symmetric methods and techniques for cryptography.
M23BEC603B.3	**Apply** asymmetric ciphers, principles for public key cryptography.
M23BEC603B.4	**Apply** the pseudo sequence generators and stream ciphers for cryptography.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC603B.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
M23BEC603B 2	3	2	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC603B.3	3	2	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC603B 4	3	2	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC603B	3	2	-	-	-	-	-	-	-	-	-	-	3	

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

10. Future with this Subject:

- **Adaptation to Technological Advancements**: As new materials and manufacturing techniques emerge, the curriculum will need to adapt to incorporate these advancements, ensuring graduates are equipped with the latest knowledge and skills to stay competitive in the rapidly evolving field of engineering. 1. Quantum Computing and Post-Quantum Cryptography

- **Quantum Threat**: Quantum computers, once fully developed, could potentially break many of the cryptographic systems currently in use, such as RSA and ECC, by efficiently solving problems like integer factorization and discrete logarithms.
- **Post-Quantum Cryptography**: In response to the quantum threat, there is a significant push towards developing cryptographic algorithms that are resistant to quantum attacks. NIST is currently standardizing post-quantum cryptographic algorithms, with lattice-based, hash-based, code-based, and multivariate polynomial cryptography being among the most promising candidates.
- **Quantum Key Distribution (QKD)**: Leveraging the principles of quantum mechanics, QKD allows two parties to generate a shared secret key, which is theoretically immune to eavesdropping. This technology, while still in its early stages, is likely to become more widespread in securing highly sensitive communications.
- **Lightweight Cryptography**: As the Internet of Things (IoT) expands, there is a growing need for cryptographic algorithms that can operate efficiently on resource-constrained devices. Lightweight cryptography aims to provide strong security with minimal computational overhead.
- **Global Cryptographic Standards**: With the rise of international cybersecurity threats, there will be a push towards more unified global standards for cryptography. This includes efforts by organizations like NIST, ISO, and other international bodies to establish guidelines that can be adopted worldwide.
- **Regulatory Compliance**: As governments and regulatory bodies become more involved in cyber security, organizations will need to ensure their cryptographic practices comply with regulations like GDPR, CCPA, and potential future legislation targeting encryption and data security.
- **Ethical Cryptography**: As cryptographic techniques become more powerful, there will be an increasing focus on ensuring that these technologies are used ethically and do not inadvertently harm individuals or society, especially in areas like surveillance, digital rights, and autonomous systems.

6th Semester	Professional Elective Course -II (PE) ARTIFICIAL INTELLIGENCE	M23BEC603C

1. Prerequisites

S/L	Proficiency	Prerequisites
1	**Mathematics and Logic**	• A strong foundation in mathematics, particularly in discrete mathematics, linear algebra, probability, and logic, is essential. • These areas are crucial for understanding algorithms, search strategies, and knowledge representation techniques in AI
2	**Programming Skills**	• Proficiency in programming languages, especially those commonly used in AI such as Python, is necessary. • Basic knowledge of Prolog will also be beneficial, as it is mentioned in the context of expert systems.
3	Data Structures and Algorithms	• A solid grasp of data structures (like trees, graphs, queues) and algorithmic concepts (like recursion, sorting, searching) is vital. • This will help in understanding search strategies, problem-solving methods, and the implementation of AI algorithms.
4	Basic Computer Science Concepts	• Familiarity with fundamental computer science concepts such as operating systems, databases, and computer architecture • This will provide a good foundation for understanding the computational aspects of AI, such as control strategies and production systems.

2. Competencies

S/L	Competency	KSA Description
1	Knowledge of Artificial intelligence concepts	**Knowledge:** Introduction to AI-Problem formulation, Problem Definition Production systems, Control strategies, Search strategies. **Skills:** Problem solving methods. **Attitudes:** Creativity, and attention to detail.
2	Search Techniques in AI	**Knowledge::** Hill Climbing-Depth first and Breath first, heuristic search strategies Best-first search, A*, AO* search. **Skills: C**hoosing appropriate searching techniques in AI for the given problem. **Attitudes:** creativity and problem-solving
3	Representation of Knowledge	**Knowledge:** Knowledge representation, Knowledge representation using Predicate logic, structured representation of knowledge **Skills:** **Attitudes:** Curiosity, creativity, and problem-solving.
4	Knowledge of Inference and Planning	**Knowledge:** Inference – Backward chaining, forward chaining. Planning overview **Skills:** Probabilistic reasoning, Fuzzy logic and reasoning **Attitudes:** Attention to detail, persistence, and critical thinking.
5	Concepts of Machine Learning	**Knowledge:** Supervised, unsupervised, and reinforcement learning; and neural networks. **Skills:** Implement machine learning algorithms; train and test models; evaluate performance. **Attitudes:** Curiosity, persistence, and critical thinking.

3. Syllabus

ARTIFICIAL INTELLIGENCE SEMESTER – VI			
Course Code	**23BEC603C**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**3:0:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours of Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course Objectives:

1. Study the concepts of Artificial Intelligence.
2. Learn the methods of solving problems using Artificial Intelligence.
3. Learn the knowledge representation techniques, reasoning techniques and planning 4. Introduce the concepts of Expert Systems and machine learning.

Module -1

Introduction: Introduction to AI-Problem formulation, Problem Definition -Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics Problem solving methods – Defining the problem as state space search, Problem graphs, Matching, Indexing and Heuristic functions.

Module -2

Search Techniques: Hill Climbing-Depth first and Breath first, heuristic search strategies Best-first search, A*, AO* search, Constraints satisfaction, Means end analysis, simulated annealing, etc. Measure of performance and analysis of search algorithms. Adversarial search –Minimax search procedure, alphabeta pruning, iterative deepening, genetic algorithms - Related algorithms, etc.

Module -3

Representation of Knowledge: Game playing - Knowledge representation, Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logic-structured representation of knowledge. Knowledge representation - Production-based system, Frame-based system, Scripts, CD, Ontologies, Semantic web and RDF

Module -4

Knowledge Inference and Planning: Inference – Backward chaining, forward chaining, Rule value approach, uncertain knowledge and reasoning: Probabilistic reasoning, Bayesian networks, Fuzzy logic and reasoning, Theory-Bayesian Network-Dempster - Shafer theory. Planning overview, components of planning system, Goal stack planning, Hierarchal planning, and other planning techniques.

Module -5

Machine Learning and Expert Systems: Overview of different forms of learning, Statistical methods, Learning Decision Trees, Neural Networks, Clustering- basic agglomerative, divisive algorithm based on similarity/dissimilarity measures. Introduction to Natural Language Processing. Architecture of expert systems, Roles of expert systems - Knowledge Acquisition –Meta knowledge. Typical expert systems - MYCIN, DART, XOON, Expert systems shells. Basic knowledge of Prolog programming language.

TEXTBOOKS:

1. Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence (SIE)", Mc Graw Hill2008.
2. Stuart Russel and Peter Norvig "AI – A Modern Approach", 2nd Edition, Pearson Education 2007 Peter Jackson, "Introduction to Expert Systems", 3 rd Edition, Pearson Education, 2007.
3. Dan W. Patterson, "Introduction to AI and ES", Pearson Education, 2007. (Unit-III).

REFERENCE BOOKS:

1. Carl Townsend, "Introduction to Turbo PROLOG", BPB Publication.
2. Ivan Bratko,"Prolog Programming for Artificial Intelligence", 3 rd Edition, Pearson Education.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-3: Introduction to AI	Introduction to AI-Problem formulation, Problem Definition -Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics Problem solving methods – Defining the problem as state space search, Problem graphs, Matching, Indexing and Heuristic functions.
2	Week 4-6: Search Techniques in AI	Hill Climbing-Depth first and Breath first, heuristic search strategies Best-first search, A*, AO* search, Constraints satisfaction, Means end analysis, simulated annealing, etc. Measure of performance and analysis of search algorithms. Adversarial search –Minimax search procedure, alpha-beta pruning, iterative deepening, genetic algorithms - Related algorithms, etc

		MYCIN, DART, XOON, Expert systems shells. Basic knowledge of Prolog programming language.
3	Week 7-9: Representation of Knowledge in AI	Game playing - Knowledge representation, Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other Logic-Structured representation of knowledge. Knowledge representation -Production based system, Frame-based system, Scripts, CD, Ontologies, Semantic web and RDF
4	Week 10-12: Knowledge Inference and Planning in AI	Inference – Backward chaining, forward chaining, Rule value approach, uncertain knowledge and reasoning: Probabilistic reasoning, Bayesian networks, Fuzzy logic and reasoning, Theory-Bayesian Network-Dempster - Shafer theory. Planning overview, components of planning system, Goal stack planning, Hierarchal planning, and other planning techniques.
5	Week 12-14: Machine Learning and Expert Systems	Overview of different forms of learning, Statistical methods, Learning Decision Trees, Neural Networks, Clustering- basic agglomerative, divisive algorithm based on similarity/dissimilarity measures. Introduction to Natural Language Processing. Architecture of expert systems, Roles of expert systems - Knowledge Acquisition –Meta knowledge. Typical expert systems -

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of Machine learning and AI concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with real world competencies.
5	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate a deeper understanding of competencies

6. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation:

This section of regulations applies to all theory-based courses. The minimum CIE marks requirements 40% of the maximum marks in each component.

CIE Split up for Professional Elective Course(PE)

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests(A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity(B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks = (A) +(B)

Average internal assessment shall be the average of the best two test marks from the 3 tests conducted.

Semester End Examination:

1. The question paper pattern will be ten questions. Each question is set for 20 marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 questions from each module, each of the two questions under a module (with a maximum of 3 sub-questions), and a mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description

1	Introduction to AI	Getting Familiar with Artificial Intelligence, its foundation and principles.
2	Search Techniques in AI	Examine the useful search techniques; learn their advantages and disadvantages.
3	Representation of Knowledge in AI	Understand knowledge representation techniques and Inference methods.
4	Real-World Application	Learn the methods of solving real-world problems using Artificial Intelligence.
5	Machine Learning and Expert Systems	Understand important concepts like Expert Systems, AI applications. Learn Prolog Programming to program intelligent systems

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

Cos	Description
M23BEC603C.1	**Understand the** concepts of Artificial Intelligence, Expert Systems and machine learning.
M23BEC603C.2	**Apply** the useful search techniques, knowledge representation techniques, reasoning techniques, Inference methods and planning for solving problems using AI; learn their advantages, disadvantages and comparison.
M23BEC603C.3	**Analyse** a range of techniques when implementing intelligent systems.
M23BEC603C.4	**Apply** appropriate AI methods to solve a given problem.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC603C.1	3	-	-	-	-	-	-	-	-	-	-	-	2	-
M23BEC603C.2	3	3	-	-	-	-	-	-	-	-	-	-	2	3
M23BEC603C.3	3	3	-	-	-	-	-	-	-	-	-	-	2	-
M23BEC603C.4	3	3	-	-	-	-	-	-	-	-	-	-	2	3
M23BEC603C	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

10. Future with this Subject:

- **Autonomous Systems and Robotics:** Autonomous vehicles, drones, and industrial robots can benefit from AI techniques like search strategies, problem-solving methods, and knowledge representation to navigate, make decisions, and interact with their environment effectively.
- **Healthcare and Medical Diagnosis:** AI-powered diagnostic systems can use knowledge inference, expert systems, and probabilistic reasoning to assist in diagnosing diseases, predicting patient outcomes, and suggesting treatment plans. Techniques like Bayesian networks, fuzzy logic, and expert systems (e.g., MYCIN) are key in handling uncertain knowledge and making informed decisions in healthcare.
- **Smart Cities and Urban Planning:** AI can be used in urban planning to optimize resource allocation, manage traffic flow, and enhance public safety by using knowledge representation, planning systems, and search algorithms. Problem-solving methods, search techniques, and planning systems are essential for modeling and optimizing complex urban environments.
- **Natural Language Processing (NLP) and Conversational AI:** Future advancements in NLP will enable more sophisticated AI-powered virtual assistants, chat bots, and translation systems that can understand and process human language more effectively.
- **AI in Finance and Trading:** AI can be used in financial markets for algorithmic trading, risk management, and fraud detection by leveraging machine learning, genetic algorithms, and search techniques. Techniques like adversarial search, optimization algorithms, and statistical methods are crucial for developing predictive models and automated decision-making systems in finance.

6th Semester	Professional Elective Course-II (PE) NETWORK SECURITY	M23BEC603D

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Security Concepts	• Basic understanding of encryption, decryption, hashing, and digital signatures. • Familiarity with concepts such as keys, certificates, and digital signatures.
2	Firewalls	• Firewalls are security devices or software that monitor and control incoming and outgoing network traffic based on predetermined security rules. They act as a barrier between trusted internal networks and untrusted external networks
3	Malicious Software	• Malicious software, often referred to as malware, is a broad term used to describe any type of software intentionally designed to cause damage to a computer, server, client, or computer network.

2. Competencies

S/L	Competency	KSA Description
1	Network Security	**Knowledge:** • Understanding of Security Protocols: Familiarity with encryption methods, authentication mechanisms, and access control models. • Awareness of Threats and Vulnerabilities: Knowledge of various types of security attacks and their potential impact. • Knowledge of Security Standards and Regulations: Understanding of compliance requirements such as GDPR, HIPAA, and PCI-DSS. **Skills:** • Technical Proficiency: Ability to implement and configure security measures, conduct vulnerability assessments, and perform incident response. • Problem-solving: Skill in analyzing and mitigating security threats and breaches. • Communication: Ability to clearly articulate security policies and procedures to stakeholders, and collaborate effectively with other IT professionals. **Attitudes:** Threat landscapes can change rapidly. A positive security attitude includes being flexible and adaptable to new information or changing circumstances, and being ready to update strategies as needed.
2	Symmetric Ciphers	**Knowledge:** Knowledge of how symmetric encryption algorithms work, including the processes of encryption and decryption using a shared secret key. Familiarity with common symmetric encryption algorithms such as AES (Advanced Encryption Standard), DES (Data Encryption Standard), 3DES (Triple DES), and Blowfish. **Skills:** Ability to implement symmetric encryption algorithms in programming languages and platforms, ensuring secure handling of keys and data. **Attitudes:** A commitment to best practices in symmetric encryption, including strong key management, secure implementation, and adherence to cryptographic standards.
3	IPSec	**Knowledge:** **Definition and Purpose:** Understand what IPSec is and why it is used to secure IP communications. **Components:** Knowledge of the core components of IPSec, including Security Associations (SAs), and the two main protocols: Authentication Header (AH) and Encapsulating Security Payload (ESP). **Skills:** Ability to configure IPSec on routers, firewalls, and VPN gateways, including setting up policies, encryption, and authentication methods. **Attitudes:** A proactive attitude toward identifying potential security threats and addressing them before they impact the system.
4	Web Security	**Knowledge:**

		Basic Concepts: Understand core concepts of web security, including confidentiality, integrity, availability, and authentication.
		Web Technologies: Familiarity with web technologies such as HTTP/HTTPS, cookies, sessions, and web APIs. **Skills:** Skills in configuring web servers securely, including setting proper permissions, disabling unnecessary services, and securing server-side scripts. **Attitudes:** They adhere to ethical guidelines and professional standards in handling web security responsibilities and responding to security incidents.

S/L	Syllabus Timeline	Description

1	Week 1-3: Introduction to Networking Security	Overview of networking security- Security Services -Confidentiality, Authentication, Integrity, Non-repudiation, access Control - Availability and Mechanisms- Security Attacks -Interruption, Interception, Modification and Fabrication

3. Syllabus

NETWORK SECURITY **SEMESTER – VI**			
Course Code	**M23BEC603D**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**3:0:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course Objectives:

1. To understand the basic concepts of security.
2. To understand the concept of authentication protocols and digital signatures.
3. To learn various methods and protocols to understand the cryptography.
4. To learn various network security attacks.
5. To understand the IP and Web security.

Module -1

FUNDAMENTALS OF NETWORKING SECURITY: Overview of networking security- Security Services -Confidentiality, Authentication, Integrity, Non-repudiation, access Control - Availability and Mechanisms- Security Attacks -Interruption, Interception, Modification and Fabrication.

Module -2

AUTHENTICATION AND SECURITY: Authentication overview - Authentication protocols - Authentication and key establishment – key exchange - mediated key exchange - User Authentication – password-based authentication -password security - Certificate Authority and key management - digital signatures – Digital Certificates.

Module -3

PUBLIC-KEY CRYPTOGRAPHY AND MESSAGE AUTHENTICATION: Basics of cryptography -cryptographic hash functions - symmetric and public-key encryption -public key cryptography principles & algorithms - cipher block modes of operation - Secure Hash Functions – HMAC

Module -4

Firewalls: The Need for Firewalls, Firewall Characteristics, Types of Firewalls, Firewall Biasing, Firewall location and configuration

Module -5

IP SECURITY AND WEB SECURITY: Network defense tools: VPNs, Intrusion Detection, and filters –E-cyber crime cyber mail privacy: Pretty Good Privacy (PGP) and S/MIME - Network security protocols in practice- Introduction to Wire shark – SSL - IPsec, and IKE -DNS security - Secure Socket Layer (SSL) and Transport Layer Security (TLS) - Secure Electronic Transaction (SET)

TEXTBOOKS:

1. Network Security Essentials (Applications and Standards) by William Stallings Pearson Education.

REFERENCE BOOKS:

1. Hack Proofing your network by Ryan Russell, Dan Kaminsky, Rain Forest Puppy, Joe Grand, David Ahmad, Hal Flynn IdoDubrawsky, Steve W.Manzuik and Ryan Permeh, Wiley Dreamtech
2. Cryptography and network Security, Third edition, Stallings, PHI/Pearson
3. A look back at Security Problems in the TCP/IP Protocol Suite, S. Bellovin, ACSAC 2004.

VIDEO LINKS:

1. https://nptel.ac.in/courses/106105031/
2. https://nptel.ac.in/courses/106105031/

4. Syllabus Timeline

2	Week 4-6: Authentication and Security	Authentication overview - Authentication protocols - Authentication and key establishment – key exchange - mediated key exchange - User Authentication –password-based authentication -password security - Certificate Authority and key management - digital signatures – Digital Certificates.
3	Week 8-11: Public-Key Cryptography and Message Authentication	Basics of cryptography -cryptographic hash functions - symmetric and publickey encryption -public key cryptography principles & algorithms - cipher block modes of operation - Secure Hash Functions – HMAC
4	Week 7-8: Security Attacks	Buffer overflow attacks & format string vulnerabilities - Denial-of-Service Attacks -Hijacking attacks: exploits and defences - Internet worms – viruses – spyware –phishing– bot-nets - TCP sessionhijacking - ARP attacks - route table modification - UDP hijacking - man-in-the-middle attacks
5	Week 9-12: IP Security and Web Security	Network defense tools: Firewalls, VPNs, Intrusion Detection, and filters – Ecyber crime cyber mail privacy: Pretty Good Privacy (PGP) and S/MIME - Network security protocols in practice- Introduction toWireshark – SSL - IPsec, and IKE -DNS security- Secure Socket Layer (SSL) and Transport Layer Security (TLS) - Secure Electronic Transaction (SET)

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of Verilog concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with real world competencies.
5	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies

6. Assessment Details (both CIE and SEE) Continuous Internal Evaluation:

The minimum CIE marks requirement is 40% of maximum marks in each component. **CIE Split up**

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks =(A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

1. Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understand fundamental network security concepts	Learn key terms such as confidentiality, integrity, availability, and how they relate to network security.
2	Network Security Protocols and Mechanisms	Learn about symmetric and asymmetric encryption techniques, such as AES and RSA. Understand the role of hash functions in ensuring data integrity (e.g., MD5, SHA-256). Study protocols like HTTPS, TLS/SSL, and their role in securing communications over a network.
3	Network Security Devices and Tools	Understand how firewalls work and their role in network security. Learn how IDS and IPS systems detect and prevent potential threats.
4	Secure Communication	Understand the basics of encryption and how to use HTTPS/TLS to protect data in transit. Learn about secure cookie attributes (e.g., HttpOnly, Secure, Same -Site) and their role in protecting against attacks like XSS and CSRF.
5	IP Security Protocols	Understand the IP Security (IPsec) protocol suite, including its key components—Authentication Header (AH) and Encapsulating Security Payload (ESP. Study how IPsec is used to create Virtual Private Networks (VPNs) for secure remote access and site-to-site connectivity.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC603D.1	**Discuss** computer and network security fundamental concepts and principles.
M23BEC603D.2	**Discuss** various authentication protocols, key exchange mechanisms, and digital certificates.
M23BEC603D.3	**Discuss** fundamental concepts of cryptography, encryption, and hashing techniques
M23BEC603D.4	**Apply** the concepts of network security in the configuration of Firewalls.
M23BEC603D.5	**Apply** the concepts of network security study protocols such as IDS, SSL, TLS, etc.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC603D.1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC603D.2	3	3	-	-	-	-	-	-	-	-	-	-	-	-
M23BEC603D.3	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC603D.4	3	3	3	-	-	3	-	-	-	-	-	-	-	-
M23BEC603D.5	3	3	3	-	-	-	-	-	-	-	-	-	3	-
M23BEC603D	**3**	**3**	**3**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**

Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

10. Future with this Subject:

- **Smart Homes and Cities:** Embedded systems will be the backbone of smart infrastructure, enabling automation, energy management, and enhanced public services.
- **Industrial IoT (IIoT):** Integration of embedded systems in manufacturing for predictive maintenance, asset tracking, and improved operational efficiency.
- **Wearable Health Devices:** Embedded systems in wearable devices for continuous health monitoring and personalized medicine.
- **Medical Imaging and Diagnostics:** Advanced embedded systems for high-precision imaging, data analysis, and automated diagnosis.
- **Secure IoT Devices:** Developing secure IoT solutions to protect against cyberattacks and data breaches.
- **Trusted Execution Environments:** Implementing secure environments within embedded systems to protect sensitive operations.

6th Semester	Open Elective- I (OE) FUNDAMENTALS OF SENSORS AND ACTUATORS	M23BEC604A

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Electrical and Electronic Concepts	Understanding of fundamental electrical principles such as voltage, current, resistance, capacitance, and inductance. This knowledge is foundational for comprehending how sensors operate and how they are integrated into measurement systems.
2	Introduction to Material Physics	Familiarity with material properties like conductivity, piezoelectricity, thermoelectric effects, and thermal properties. This is important for understanding the materials used in various sensors and how they respond to physical stimuli.
3	Analog and Digital Electronics	Knowledge of analog circuits and digital electronics (e.g., digital-to-analog converters, microcontrollers). This is essential for processing and interpreting signals from sensors.

2. Competencies

S/L	Competency	KSA Description
1	Understanding of Sensors	**Knowledge**: Comprehensive understanding of various sensor types (e.g., thermoelectric, piezoelectric, resistive), their operating principles, and the materials used in their construction. **Skills**: Ability to select appropriate sensors for specific applications, interpret sensor specifications, and integrate sensors into systems. **Attitudes**: Curiosity and openness to explore new sensor technologies, and a commitment to staying updated with advancements in sensor materials and designs.
2	Proficiency in Measurement Techniques	**Knowledge**: Deep understanding of measurement principles, including static and dynamic characteristics, error analysis, and calibration methods. **Skills**: Competence in setting up measurement systems, using multimeters, voltmeters, and other measurement instruments, and applying error correction techniques. **Attitudes**: Precision and attention to detail in conducting measurements, and a commitment to accuracy and reliability in data collection.
3	Practical Application and Problem-Solving	**Knowledge**: Applied knowledge of sensor technologies and measurement systems in real world contexts, such as industrial automation, environmental monitoring, and healthcare. **Skills**: Capabilities to apply theoretical knowledge to practical situations, troubleshoot issues, and optimize system performance. **Attitudes**: Proactive and solution-oriented mindset, with a willingness to experiment and innovate in practical applications

4	Ethical and Safety Considerations	**Knowledge**: Understanding of the ethical implications of using sensor technology, including data privacy, and awareness of safety standards in sensor design and application. **Skills**: Ability to design and implement systems that adhere to ethical guidelines and safety regulations, and to conduct risk assessments. **Attitudes**: Responsibility and integrity in handling sensitive data, and a commitment to safety and ethical practices in engineering design

3. Syllabus

Fundamentals of sensors and actuators **SEMESTER – VI**			
Course Code	**M23BEC604A**	CIE Marks	**50**
Number of Lecture Hours/Week (L: T: P: S)	**3:0:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course objectives: This course will enable students to:

1. Understand various technologies associated in the manufacturing of sensors.
2. Acquire knowledge about the types of sensors used in modern digital systems.
3. Get acquainted with material properties required to make sensors.
4. Understand types of instrument errors and circuits for multirange Ammeters and Voltmeters.
5. Describe the principle of operation of digital measuring instruments and Bridges.
6. Understand the operations of transducers and instrumentation amplifiers

Module -1

Introduction to sensor based measurement systems: General concepts and terminology, sensor classification, Primary Sensors- Temperature Sensors, Pressure Sensors, Flow Velocity and Flow Rate sensors, Level sensors, material for sensors, microsensor technology.

Module -2

Self-generating Sensors-Thermoelectric sensors, piezoelectric sensors, pyroelectric sensors, photovoltaic sensors, electrochemical sensors.

Module -3

Radiation sensors: Introduction – Basic Characteristics – Types of Photosensistors– X-ray and Nuclear Radiation Sensors– Fiber Optic Sensors. Electro Analytical Sensors: Introduction – The Electrochemical Cell – The Cell Potential –Standard Hydrogen Electrode (SHE) – Liquid Junction and Other Potentials – Sensor Electrodes.

Module -4

Smart Sensors: Introduction, Primary Sensors, Excitation, Converters, Compensation, Information Coding/Processing, Data Communication, Standards for Smart Sensor Interface, the Automation. Sensors Applications: Introduction, On-board Automobile Sensors (Automotive Sensors), Home Appliance Sensors

Module -5

Actuators: Pneumatic and Hydraulic Actuation Systems, Valves, Rotary actuators, Mechanical Actuation Systems Electrical Actuation Systems,HVAC,BHM

Text Books:
1. "Sensors and Signal Conditioning", Ramon Pallas Areny, JohnG. Webster,2nd edition, John Wiley and Sons,2000
2. D. Patranabis, ―Sensors and Transducers‖, PHI Learning Private Limited.

Reference Books:
3. W. Bolton-Mechatronics, Pearson Education Limited.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-3: Sensor based measurement systems	Understanding the principles, types, applications, data processing, and integration of sensors for accurate measurement and analysis across various domains. Understand the material properties required to make sensors and Describe the manufacturing process of sensors.
2	Week 4-6: Selfgenerating Sensors	Working principle of self-generating sensors, Thermoelectric sensors, piezoelectric sensors, pyro electric sensors, photovoltaic sensors, electrochemical sensors..
3	Week 7-8: Radiation sensors	Understanding the working principle of types of photosensistors xray nuclear radiation sensors, fiber optic sensors, electrical sensors, electromechanical sensors the cell standard hydrogen electrode
4	Week 9-10: Smart sensors	Understanding the primary sensors, excitation sensors, compensation, information coding processor data communication
5	Week 11-12: Actuators	Understanding the pneumatic and hydraulic systems,totary actuators mechanical actuation system

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of sensors concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
5	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
6	Project -Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies

6. Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	3	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks =(A) + (B)

Average internal assessment shall be the average of the best two test marks from the 3 tests conducted. Three Unit Tests each of **25 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester Two assignments each of **25 Marks**
- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding of sensors	Understand material properties required to make sensors, various technologies associated in manufacturing of sensors and various types of sensors used in modern digital systems.
2	Understanding of Instrumentation	Understand types of instrument errors, circuits for Multi range Ammeters and Voltmeters and the operations of transducers, instrumentation amplifiers, digital measuring instruments and Bridges.
3	Project-Based Learning	Through hands-on projects, students will apply their knowledge of sensor techniques of future projects, reinforcing their understanding of theoretical concepts.
4	Collaboration and Communication Skills	Students will work collaboratively in teams on design projects, enhancing their ability to communicate effectively, share ideas, and solve problems collectively.
5	Ethical and Professional Responsibility	Students will understand the ethical and professional responsibilities associated with sensors and instrumentation design, including respecting intellectual property rights, ensuring design reliability and security, and adhering to industry standards and best practices.
6	Understanding of sensors	Understand material properties required to make sensors, various technologies associated in manufacturing of sensors and various types of sensors used in modern digital systems.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description

M23BEC604A.1	**Explain** the concept of primary sensors, material properties required and technologies associated in manufacturing of sensors, digital measuring instruments, bridges and transducers.
M23BEC604A.2	**Apply** the principle of operation of sensors to measure various network parameters.
M23BEC604A.3	**Apply** the sensor and actuator characteristics for measuring parameters.
M23BEC604A.4	**Analyze** the types of sensors used in modern digital systems to determine their suitability for different applications

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC604A.1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC604A.2	3	2	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC604A.3	3	2	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC604A.4	3	2	3	-	-	-	-	-	3	-	2	-	3	-
M23BEC604A	3	2	3	-	-	-	-	-	3	-	2	-	3	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**10**					
Module 2		**10**				
Module 3			**10**			
Module 4				**10**		
Module 5					**10**	
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**20**					
Module 2		**20**				
Module 3			**20**			
Module 4				**20**		
Module 5					**20**	
Total	**20**	**20**	**20**	**20**	**20**	**100**

10. Future with this Subject:

- **Internet of Things (IoT) Integration**: Sensors will continue to play a crucial role in the expansion of IoT ecosystems. With sensors embedded in everyday objects and devices, they'll enable seamless data collection, analysis, and automation. This integration will lead to smarter homes, cities, factories, and transportation systems.
- **Miniaturization and Wearables**: Sensors will become smaller, more efficient, and cheaper, enabling their integration into wearable devices for healthcare monitoring, fitness tracking, and augmented reality applications. These wearable sensors will provide real-time data on vital signs, movement, and environmental factors, revolutionizing personal health and wellness.
- **Advanced Medical Diagnostics and Treatment**: Sensor technology will advance medical diagnostics and treatment through devices like biosensors, implantable sensors, and wearable health monitors. These innovations will enable early detection of diseases, personalized treatment plans, and remote patient monitoring, improving healthcare outcomes and reducing costs.
- **Autonomous Vehicles**: Sensors such as LiDAR, radar, and cameras are critical components of autonomous vehicles, enabling them to perceive their surroundings and navigate safely. As autonomous vehicle technology matures, sensor fusion techniques will become more sophisticated, enhancing the vehicles' perception and decision-making capabilities.

- **Environmental Monitoring and Sustainability**: Sensors will continue to play a vital role in monitoring environmental parameters such as air quality, water quality, and soil conditions. These sensors will help governments, industries, and communities track pollution levels, manage resources more efficiently, and mitigate environmental risks, contributing to sustainability efforts.
- **Industrial Automation and Industry 4.0**: In manufacturing and industrial settings, sensors will drive the adoption of Industry 4.0 principles, enabling smart factories and automation. Sensors integrated with machines and production systems will enable real-time monitoring, predictive maintenance, and optimization of manufacturing processes, leading to increased productivity and cost savings.
- **Quantum Sensors**: The emergence of quantum sensors holds promise for ultra-sensitive measurements in various fields, including navigation, imaging, and fundamental research. Quantum sensors leverage the principles of quantum mechanics to achieve unprecedented levels of precision and sensitivity, opening up new possibilities for scientific discovery and technological innovation.
- **AI and Data Analytics**: With the proliferation of sensors generating vast amounts of data, AI and data analytics will play a crucial role in extracting actionable insights. Machine learning algorithms will analyze sensor data to identify patterns, anomalies, and trends, enabling predictive maintenance, optimization, and decision support across multiple domains.
- **Project Work and Research:** sensors and instrumentation serve as vital tools for data collection, analysis, and validation across diverse disciplines. Researchers leverage advanced sensor technologies, including but not limited to IoT devices, spectroscopic sensors, and precision measurement instruments, to monitor experimental conditions, environmental variables, and performance metrics in real-time. Integration with emerging technologies such as AI and remote sensing enables researchers to gather comprehensive data, facilitate interdisciplinary collaboration, and accelerate scientific discovery. Customizable and scalable sensor platforms empower researchers to tailor solutions to specific project requirements, while ensuring data security and privacy remains a priority.

6th Semester	Open Elective -I (OE) FUNDAMENTALS OF MOBILE COMMUNICATION	M23BEC604B

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basics knowledge of Electronics	Familiarity with fundamentals of electronic devices, Cellular concepts
2	Basic knowledge of Communication	Basics of communication, Information theory, Electromagnetis
5	Previous Coursework	Mathematics, Physics, Probability & Random Processes

2. Competencies

S/L	Competency	KSA Description
1	Introduction to Mobile Communication	**Knowledge:** Cellular concept, cell organization, Channel capacity **Skills:** Basics of regarding cell structure, interference, handoff **Attitudes:** Approach towards problems , breaking them down into parts
	Mobile Radio Transmission	**Knowledge**: Understanding frequencies for radio propagation **Skills:** Modulation, Spread spectrum **Attitudes:** Propagation mechanisms, modulation

3	Mobile MAC Layer	**Knowledge:** Understanding principle of MAC layer **Skills:** Multiplexing technique, Modulation, Multiple Access **Attitudes:** Valuing the importance of Multiplexing, Multiple Access
4	Mobile Network Layer	**Knowledge:** Understanding principle of Network Layer **Skills:** Mobile IP, Packet delivery, DHCP, Routing Protocol **Attitudes:** Valuing the importance of Mobile IP , diversity technique
5	Telecommunication System	**Knowledge:** Basics of GSM, Radio Interface, Handover Skills: Understanding of GSM Architecture **Attitudes**: knowing the base station working, signaling technique, Services

3. Syllabus

FUNDAMENTALS OF MOBILE COMMUNICATION SEMESTER – VI			
Course Code	**M23BEC604B**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**3:0:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**
Course objectives: This course will enable students to: • To know the evolution of mobile communication and cellular concepts • To know the basics of propagation of radio signals fading mechanism, and effect of fading. • To know the concepts of spread spectrum, GSM CDMA, and advanced Cellular Systems • To Know the design considerations and architecture for Wireless Systems like GSM, CDMA • To know the basic principles of radio resource management techniques			
Module -1 Introduction to Mobile Communication			

Introduction, History of wireless communication Location dependent devices Mobile and wireless devices, Reference model, Cellular Telephone systems, The cellular system Concepts- Introduction, frequency reuse, Channel assignment strategies, Handoff Strategies , Interference and system capacity, Improving coverage and Capacity in cellular system	L1, L2, L3
Module -2 Mobile Radio Transmission	
Regulations ,Frequencies for radio transmission : Signals, Antennas, Signal propagation: Pathloss of radio signals,, Multi-path propagation, Multiplexing: -Space division multiplexing, Frequency division multiplexing,, Time division multiplexing, Code division multiplexing , Modulation : ASK, FSK,PSK, AFSK , APSK, Multi-carrier modulation: Spread spectrum : Direct sequence spread spectrum , Frequency hopping spread spectrum	L1, L2, L3
Module -3 Mobile MAC Layer	
Motivation for a specialized MAC: Hidden and exposed terminals, Near and far terminals Classical Aloha, Slotted Aloha , Carrier sense multiple access, Demand assigned multiple access, PRMA packet reservation multiple access , Reservation TDMA, Multiple access with collision avoidance, Polling, Inhibit sense multiple access	L1, L2, L3
Module -5 Mobile Network Layer	
Mobile IP: Goals, assumptions and requirements, Entities and terminology, IP packet delivery. Agent discovery, Registration, Tunneling and encapsulation, Optimizations, Reverse tunneling , IPv6 , IP micro-mobility support, Dynamic host configuration protocol Mobile ad-hoc networks: Routing, Destination sequence distance vector ,Dynamic source routing ,Alternative metrics, Overview ad-hoc routing protocol	L1, L2, L3
Module -5 Telecommunication System	
Global System for Mobile Communication (GSM), Mobile services ,System architecture m, Radio interface, Protocols, Localization and calling . Handover ,Security , New data services	L1, L2, L3

Text Books:

1. Mobile Communication: Jochen Schiller 2nd Edition Peaerson Education 2003, Addison Wesley
2. Wireless Communications Principles and Practice, Theodore S. Rappaport - 2nd Edition, Pearson Education, 2003. Prentice hall publisher
3. GSM Networks: Protocols, Terminology and Implementation by Gunnar Heine, 1999 Artech House, **Reference**

Books:

1. Wireless and Mobile Network Architectures, Yi-Bing Lin - 2nd Edition, Wiley, 2008
2. Mobile Cellular Communications, 2nd Edition, W.C.Y. Lee MC Graw Hill, 1995.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Introduction to Mobile Communication	Introduction , History of wireless communication Location dependent devices Mobile and wireless devices , Cellular Telephone systems,, The cellular system Concepts- Handoff Strategies , Interference and system capacity, Improving coverage and Capacity in cellular system
2	Week 3-4: Mobile Radio Transmission	Regulations, Frequencies for radio transmission: Signals, Antennas, Signal propagation: Path loss of radio signals,, Multi-path propagation, Multiplexing: - SDMA, FDMA, TDMA, CDMA, Modulation : ASK, FSK,PSK, AFSK, APSK, Multi-carrier modulation: Spread spectrum : Direct sequence spread spectrum , Frequency hopping spread spectrum
3	Week 5-6: Mobile MAC Layer	Motivation for a specialized MAC: Hidden and exposed terminals, Near and far terminals Multiplexing Technique, Classical Aloha, Slotted Aloha , Carrier sense multiple access, Demand assigned multiple access, Multiple access with collision avoidance, Polling, Inhibit sense multiple access

4	Week 7-8: Mobile Network Layer	Mobile IP: IP packet delivery. Agent discovery, Registration, Tunneling and encapsulation, Optimizations, Reverse tunneling , IPv6 , IP micro-mobility support, Dynamic host configuration protocol Mobile ad-hoc networks: Routing, Types of Routing ,routing ,Alternative metrics, Overview ad-hoc routing protocol
5	Week 9-10: Telecommunication System	Global System for Mobile Communication (GSM) , Mobile services System architecture m, Radio interface, Protocols, Localization and calling .Handover ,Security , New data services
6	Week 11-12: Integration and Applications	Introduction Mobile Communication Cellular concepts, Mobile Radio Propagation, Mobile Medium Access Control, Mobile Network Layer, communication , Telecommunication System

5. Teaching-Learning Process Strategies

Sr. No	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of Verilog concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6	Multiple Representations	Introduce topics in various representations to reinforce competencies
7	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
8	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
9	Programming Assignments	Assign programming tasks to reinforce practical skills associated with competencies.

6. Assessment Details (both CIE and SEE) Note:

Formative, Summative, and other Assessments shall be conducted as per the Institution's calendar of events in all the courses of the programme offered to the students, within the framework of the Scheme of Teaching and Evaluation.

Assessments and Evaluation Process:

1) CIE and SEE constitute the major evaluations prescribed for each course, with only those students maintaining a minimum standard in CIE are permitted to appear in the SEE of the course.
2) CIE and SEE are to carry 50% weightage each, to enable the course to be evaluated for a total of 100 marks, irrespective of its credits.
3) The evaluation system of the programme is comprehensive and continuous during the entire period of the Semester, by the faculty who is teaching the course. For a course, the evaluation and grading will be on the following parameters:

A	Continuous Internal Evaluation (CIE)	25 marks
B	Internal Assessment Tests (IAT)	25 marks
Total of CIE (A+B)		50 marks
C	Semester End Examination (SEE)	50 marks
Total of CIE and SEE (A+B+C)		**100 marks**

Continuous Internal Evaluation (CIE)

The minimum CIE marks requirement is 40% of the maximum marks in each component.

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks = (A) + (B)

The average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examinations:

1. The question paper pattern will be ten questions. Each question is set for 20 marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 questions from each module, each of the two questions under a module (with a maximum of 3 sub-questions), may have a mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks.

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding Fundamentals	Understand the evolution of cellular and mobile communication concepts to improve capacity of the system. Spread spectrum, CDMA, GSM architecture
2	Understanding Functionalities	Understand the basic functionalities of mobile radio wave propagation, smallscale fading, and large-scale fading, Spread spectrum, CDMA, GSM,
4	Understanding Algorithms	Understand the algorithms for cellular systems, spread spectrum GSM and CDMA wireless networks
5	Understanding Implementation	Understand the implementation of cellular communication systems, services of GSM, CDMA, Equalization and Diversity technique
5	Collaboration and Communication Skills	Students will work collaboratively in teams on design systems, enhancing their ability to communicate effectively, share ideas, and solve problems collectively.
6	Ethical and Professional Responsibility	Students will understand the ethical and professional responsibilities associated with cellular communication systems including respecting intellectual property rights, ensuring design reliability and security, and adhering to industry standards and best practices.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

Cos	Description
M23BEC604B.1	**Explain** the concepts related to cellular systems, Propagation radio signals and models, spread spectrum and CDMA, GSM system, equalizers, and diversity
M23BEC604B.2	**Apply** the concepts of cellular communication, Mobile radio wave propagation radio signals and models and spread spectrum and CDMA, GSM , Equalizers, and diversity, to evaluate different parameters
M23BEC604B.3	**Analyze** the related cellular system, Propagation of radio signals and models, Spread spectrum and CDMA, GSM Equalizers and diversity
M23BEC604B.4	**Compute** Various Parameters related cellular system , Propagation radio signals and models spread spectrum ,CDMA, GSM , Equalizers and diversity

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC604B.1	3	3	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC604B.2	3	3	-	-	-	-	-	-	-	-	-	-	3	-

M23BEC604B.3	3	3	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC694B.4	3	3	-	-	-	-	-	-	-	-	-	-	3	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	**12**				**12**
Module 2		**13**			**13**
Module 3			**12**		**12**
Module 4				**13**	**13**
Total	**12**	**13**	**12**	**13**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	**24**				**24**
Module 2		**26**			**26**
Module 3			**24**		**24**
Module 4				**26**	**26**
Total	**24**	**26**	**24**	**26**	**100**

10. Future with this Subject

The "Mobile Communication "course in the third semester of the B.E program lays a strong foundation for several future courses in the undergraduate program. The contributions of this subject extend across various areas, enhancing the student's understanding and skills in the field of Communications.

Mobile communication will continue to evolve to meet the changing needs of users. We can expect to see more integration between different devices and platforms, as well as advancements in artificial Intelligence and machine Learning. The rise of mobile computing and the Internet of Things (IoT) will also play a major role in shaping the future of Mobile communication systems.

The future of "Mobile communication "holds immense potential for revolutionizing the way we interact with technology. From AI integration to cloud-based systems, IoT integration, enhanced security measures, and user-centric design, these developments promise to make communication and computing more efficient, seamless, and personalized. The features are: Better download speed.

6th Semester	Open Elective -I (OE) FUNDAMENTALS OF EV'S	M23BEC604C

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Physics	Basic knowledge of Physics that covers principles of Newton's laws of forces.
2	Basic Electrical Engineering	Understanding the fundamentals of electricity, circuits, and electronics is crucial. This includes knowledge of voltage, current, resistance and power
3	Software and Control Systems	Proficiency in software used for vehicle control systems, including embedded systems and programming languages like C/C++, is beneficial.
4	Safety Standards and Regulations	Awareness of the safety standards and regulations governing electrical vehicles, including those related to battery safety.
5	Environmental Impact	Understanding the environmental benefits and challenges of EVs, including lifecycle analysis and the impact of battery production and disposal.

2. Competencies

S/L	Competency	KSA Description
1	Knowledge of vehicle dynamics	**Knowledge:** Fundamental laws of motion and various features of vehicles **Skills:** Vehicle Kinetics, velocity and acceleration for different road conditions. **Attitudes:** Vehicle adaptability considering various parameters based on road structure.
2	Performance Characteristics of Electric and Hybrid Electric Vehicles	**Knowledge:** Configurations, performance and characteristics of electric & hybrid vehicles **Skills:** Hybrid electric drive train for series and parallel structures. **Attitudes:** Traction and tractive effort, transmission requirement.
3	Battery details	**Knowledge:** Types of batteries, capacity of the battery and its characteristics. **Skills:** Analysis and selection of batteries depending on the applications. **Attitudes:** Cells basic operation, SOC and types of connections
4	Vehicle grid interface	**Knowledge:** Vehicle grid interface and fast charging concepts **Skills:** Grid impact of fast charges and electric vehicles in microgrids. **Attitudes:** Primary and secondary level of controls and tertiary control.
5	Design of electric and hybrid vehicles	**Knowledge:** Design specifications and calculations of series and parallel hybrid electric drive trains **Skills:** Operating pattern and control strategies **Attitudes:** Various control strategies in the design of series and parallel hybrid electric drive train.

3. Syllabus

FUNDAMENTALS OF EV'S SEMESTER – VI			
Course Code	**M23BEC604C**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**3:0:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course Objectives:

1. To understand the fundamental laws and vehicle mechanics.
2. To understand the working of Electric Vehicles and recent trends.
3. To understand different energy storage systems used in electric vehicles.
4. To analyze different power grid used for electric vehicle application.

Module -1
Fundamentals of Electric and Hybrid Vehicles **Introduction**, Electric Vehicles, Hybrid Electric Vehicles, Electric and Hybrid Vehicle components, Electric Motor and Engine ratings, Recent EVs and HEVs, EV/ICEV Comparison, Electric Vehicle Market **Vehicle Dynamics**: Roadway Fundamentals, Laws of Motion, Vehicle Kinetics, Dynamics of Vehicle Motion, Propulsion power, Force-Vehicle Characteristics, Maximum Gradability, Velocity, and acceleration Constant, Level Road, Vehicle profile, Distance traversed, Tractive power Energy requirement (Excluding Derivations)
Module -2
Electric and Hybrid Electric Vehicles Configuration of Electric Vehicles, Performance of Electric Vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption. Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains (Excluding classification).
Module -3
Energy storage for EV and HEV Energy storage requirements, Battery parameters, Types of Batteries, Modelling of Battery, Fuel Cell basic principle and operation, Types of Fuel Cells, Proton Exchange Membrane Fuel Cell (PEMFC) and its operation, Modelling of PEMFC, Super capacitors.
Module -4
Power Grid of Electric Vehicles Vehicle grid interface -electric vehicle charging -dc fast chargers,480 V Fast Charger, MV Fast Charger, Electric vehicle Charging station, Grid impact of fast chargers, Electric vehicles in micro grids. Micro grid and controls --Primary- and Secondary-Level Controls, Droop-Based Controls, Oscillator-Based Controls, Tertiary control,V2h and h2V power converter, Solar generation Integration with electric Vehicles -- Coordinated Control of Solar PV Generation, Storage and PEV
Module -5
Design of Electric and Hybrid Electric Vehicles **Series Hybrid Electric Drive Train Design:** Introduction, Operating patterns, control strategies, Maximum State Of Charge of Peaking Power Source Control Strategy, Engine On–Off or Thermostat Control Strategy, Sizing of major components, power rating of traction motor, power rating of engine/generator, design of PPS **Parallel Hybrid Electric Drive Train Design:** Control strategies of parallel hybrid drive train, Maximum SOC-of-PPS Control Strategy, Engine On–Off (Thermostat) Control Strategy, Constrained Engine On–Off Control Strategy, Fuzzy Logic Control Technique.
TEXTBOOKS: 1. Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, "Modern Electric, Hybrid Electricand Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2009. 2. Electric and Hybrid Vehicles: Design Fundamentals by Iqbal Husain, CRC Press, 2003. **Web LINKS:** 1. https://archive.nptel.ac.in/courses/108/106/108106170/

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-3:	**Introduction**, Electric Vehicles, Hybrid Electric Vehicles, Electric and Hybrid Vehicle components, Electric Motor and Engine ratings, Recent EVs and HEVs, EV/ICEV Comparison, Electric Vehicle Market **Vehicle Dynamics**: Roadway Fundamentals, Laws of Motion, Vehicle Kinetics, Dynamics of Vehicle Motion, Propulsion power, Force-Vehicle Characteristics, Maximum Gradability, Velocity, and acceleration Constant, Level Road, Vehicle profile, Distance traversed, Tractive power Energy requirement (Excluding Derivations)

2	Week 4-6:	Configuration of Electric Vehicles, Performance of Electric Vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption. Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains
3	Week 8-11:	Energy storage requirements, Battery parameters, Types of Batteries, Modelling of Battery, Fuel Cell basic principle and operation, Types of Fuel Cells, Proton Exchange Membrane Fuel Cell (PEMFC) and its operation, Modelling of PEMFC, Super capacitors.
4	Week 7-8:	Vehicle grid interface -electric vehicle charging -dc fast chargers,480 V Fast Charger, MV Fast Charger, Electric vehicle Charging station, Grid impact of fast chargers, Electric vehicles in micro grids. Micro grid and controls - Primary- and Secondary-Level Controls, Droop-Based Controls, OscillatorBased Controls, Tertiary control,V2h and h2V power converter, Solar generation Integration with electric Vehicles --Coordinated Control of Solar PV Generation, Storage and PEV
5	Week 9-12:	Series Hybrid Electric Drive Train Design: Introduction, Operating patterns,
		control strategies, Maximum State Of Charge of Peaking Power Source Control Strategy, Engine On–Off or Thermostat Control Strategy, Sizing of major components, power rating of traction motor, power rating of engine/generator, design of PPS Parallel Hybrid Electric Drive Train Design: Control strategies of parallel hybrid drive train, Maximum SOC-of-PPS Control Strategy, Engine On–Off (Thermostat) Control Strategy, Constrained Engine On–Off Control Strategy, Fuzzy Logic Control Technique.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos to enhance understanding of vehicle dynamics.
3	Collaborative earning	Encourage collaborative learning for improved competency application.
4	Higher Order Thinking (HOTS) Questions	Pose HOTS questions to stimulate critical thinking related to each competency.
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6	Multiple Representations	Introduce topics in various representations to reinforce competencies
7	Real-World Application	Discuss practical applications to connect theoretical concepts with realworld competencies.

6. Assessment Details (both CIE and SEE) Continuous Internal Evaluation:
The minimum CIE marks requirement is 40% of maximum marks in each component. **CIE Split up**

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10

(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks =(A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

1. Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Basics of vehicle dynamics	Study of Electric Vehicles, Hybrid Electric Vehicles, Electric and Hybrid Vehicle components, Electric Motor and Engine ratings, Recent EVs and HEVs, EV/ICEV Comparison, Electric Vehicle Market Roadway Fundamentals, Laws of Motion, Vehicle Kinetics, Dynamics of Vehicle Motion, Propulsion power, Force-Vehicle Characteristics, Maximum Gradability, Velocity, and acceleration Constant, Level Road, Vehicle profile, Distance traversed, Tractive power Energy requirement
2	Performance characteristics of Electric and Hybrid Electric Vehicles	Configuration, Performance, Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption. Concept and Architecture of Series &Parallel hybrid electric drive trains
3	Understand different energy storage systems used in electric vehicles	Energy storage requirements, Battery parameters, Types and Modelling of Batteries, Fuel Cell basic principle and operation, Types of Fuel Cells, Proton Exchange Membrane Fuel Cell (PEMFC) and its operation, Modelling of PEMFC, Super capacitors.
4	Understand the grid to vehicle and vehicle to grid connection technology	Vehicle grid interface -electric vehicle charging -dc fast chargers,480 V Fast Charger, MV Fast Charger, Electric vehicle Charging station, Grid impact of fast chargers, Electric vehicles in micro grids. Micro grid and controls - Primary- and Secondary-Level Controls, Droop-Based Controls, OscillatorBased Controls, Tertiary control,V2h and h2V power converter, Solar generation Integration with electric Vehicles --Coordinated Control of Solar PV Generation, Storage and PEV
5	Study the design of electric and hybrid vehicles	Series Hybrid Electric Drive Train Design: Introduction, Operating patterns, control strategies, Maximum State Of Charge of Peaking Power Source Control Strategy, Engine On–Off or Thermostat Control Strategy, Sizing of major components, power rating of traction motor, power rating of engine/generator, design of PPS, Parallel Hybrid Electric Drive Train Design: Control strategies of parallel hybrid drive train, Maximum SOC-of-PPS Control Strategy, Engine On–Off (Thermostat) Control Strategy, Constrained Engine On–Off Control Strategy, Fuzzy Logic Control Technique.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC604C.1	Explain the vehicle dynamics
M23BEC604C.2	Interpret architecture design and components assembly system of an EV
M23BEC604C.3	Compute system modelling of an EV bus network
M23BEC604C.4	Illustrate maintenance procedures and processes for power train system

M23BEC604C.5	Predict vehicle fast charging, Vehicle grid interface, vehicle navigation, operation and control

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC604C.1	3	-	-	-	-	-	-	-	-	-	-	-		-
M23BEC604C.2	3		3	-	-	-	-	-	-	-	-	-	-	3
M23BEC604C.3	3	-			-	3	-	-	-	-	-	-		-
M23BEC604C.4	3	-	-		-	-	-	-	-	-	-	-	-	
M23BEC604C.5	3	-		-	-	-	2	-	-	-	-	3		
M23BEC604C	3		3		-	3	2	-	-	-	-	3		3

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	Total
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

10. Future with this Subject:

The future of electric vehicles (EVs) looks incredibly promising and transformative. Here are some key trends and developments:

- Increased Adoption: By 2025, it's expected that 20% of all new cars sold globally will be electric. This number is projected to rise to 40% by 2030 and nearly 100% by 2040.
- Diverse Models: A wide range of new EV models are set to hit the market in the coming years. Some exciting upcoming models include the Kia EV9, Chevrolet Silverado EV, Tesla Cybertruck, and Porsche Macan EV.
- Technological Advancements: Innovations in battery technology are leading to longer ranges and faster charging times. This will make EVs more convenient and practical for everyday use.
- Government Policies: Many governments are setting ambitious targets to phase out internal combustion engine vehicles. For example, Jaguar plans to sell only electric cars from 2025, and Volvo from 2030.
- Infrastructure Development: The expansion of charging infrastructure is crucial. More charging stations are being installed globally, making it easier for EV owners to charge their vehicles.
- Environmental Impact: EVs are seen as a key solution to reducing greenhouse gas emissions and combating climate change. As the electricity grid becomes greener, the environmental benefits of EVs will continue to grow.

6th Semester	Open Elective – I (OE) AUTOMOTIVE ELECTRONICS	M23BEC604D

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Mathematics	Proficiency in Summation, Differentiation and Integration.
2	Basic Electricals	Proficiency in terminologies of Basic Electricals like Voltage, Current, Power, Logic gates and working of Transformer, Transistor, Voltage Regulator circuit, Operational Amplifiers.
3	Basics of Mechanical	Familiarity in the terminologies and working of mechanical systems.
4	Control Systems	Proficiency in open loop control system and closed loop control system, Translational and Rotational Mechanical Systems.

AUTOMOTIVE ELECTRONICS SEMESTER – VI			
Course Code	**M23BEC604D**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**3:0:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course Objectives: This course will enable students to:
1. Understand the complete dynamics of automotive electronics.

2. Competencies

S/L	Competency	KSA Description
1	Automotive Fundamentals	**Knowledge:** Basics of transmission system, Electrical system, Fuel System, braking system, Steering and Suspension systems. **Skills:** Applying the basics of transmission system, Electrical system, Fuel System, braking system, Steering and Suspension systems to understand the working of 4 stroke cycle, Diesel engine. **Attitudes:** Critical Thinking.
2	Familiarity with Sensors and Actuators	**Knowledge:** Understanding the basic concept of different types of sensors. **Skills:** Applying the basic concept of sensors to understand the working of sensors and actuators. **Attitudes:** Mathematical Aptitude, Problem Solving ability, Critical Thinking.
3	Proficiency in Electronic Engine Control	**Knowledge:** Familiarity with the basics and working of different types of sensors. **Skills:** Applying basics and working of different types of sensors to understand Electronic Engine control systems. **Attitudes:** Mathematical Aptitude, Problem Solving ability, Critical Thinking.
4	Proficiency in Vehicle Motion Control	**Knowledge:** Understanding of fundamental of control systems, sensors, actuators. **Skills:** Applying of fundamental of control systems, sensors, actuators to understand the working of Vehicle Motion Control system. **Attitudes:** Mathematical Aptitude, Problem Solving ability, Critical Thinking.
5	Proficiency in Advanced Driver Assistance System	**Knowledge:** Understanding of fundamental of control systems, sensors, actuators, Advanced Driver Assistance System. **Skills:** Applying of fundamental of different sensors ,actuators to understand ADAS Features. **Attitudes:** Mathematical Aptitude, Problem Solving ability, Critical Thinking.

3. Syllabus

2. Understand sensor network for mechanical fault diagnostics in an automotive vehicle. 3. Implement various control requirements in automotive system.
Module -1
Automotive Fundamentals: Use Of Electronics In The Automobile, The Engine-Engine block, Cylinder Head, The 4 stroke cycle, Engine Control, Ignition System-Spark Plug, High-Voltage circuit and Distribution, Spark Pulse generation, Ignition Timing, Diesel Engine, Drive train-Transmission, Drive Shaft, Differential, Suspension, Brakes, Steering System.
Module -2

Sensors and Actuators:
Automotive Control Systems Applications of sensors and actuators, Air Flow Rate Sensor-Indirect measurement of Mass Air Flow, Engine crankshaft angular position sensor- Magnetic Reluctance Position Sensor, Hall-effect Position Sensor, Throttle Angle Sensor, Temperature Sensor, Automotive engine control actuators- Fuel Injection, Exhaust Gas Recirculation actuator, Variable Value Timing(VVT).

Module -3

The Basics of Electronic Engine control:
Motivation for Electronic Engine Control-Exhaust Emissions, Fuel Economy, Concept of An Electronic Engine Control System, Definition of General Terms, Definition of Engine Performance Terms, Control Strategy, Electronic fuel control system, Engine control sequence-open loop and closed loop, Electronic Ignition.

Module -4

Digital Engine Control Systems:
Digital engine control Features, Control Modes for Speed Control, Engine speed sensor, Timing sensor for ignition and fuel delivery, Electronic ignition control-closed loop ignition timing, Integrated Engine Control System.

Vehicle Motion Control:
Typical Cruise control system, Digital cruise control, Speed Response Curves, Throttle Actuator Cruise control electronics, Stepper motor-based actuator, Antilock Braking System(ABS), Electronic suspension system.

Module -5

Introduction to Advanced Driver Assistance System:
Introduction, Overview of ADAS, Active Safety system and Automated driving system, ADAS Features-Advanced Cruise control, Adaptive Light control, Blind spot detection, Lane Departure warning, Lane keeping Assistance, Driver Alert system, Cross Traffic Alert, Parking Assistant systems, Night Vision.

TEXTBOOKS:

1. William B. Ribbens, "Understanding Automotive Electronics", SAMS/Elsevier publishing, 6thEdition, 1997.
2. Robert Bosch GmbH, "Automotive Electrics and Automotive Electronics-Systems and Components, Networking and Hybrid Drive", Springer Vieweg, 5th Edition, 2007.
3. Steve Zack, Kurt Shadbolt, Scott Brown “Advanced Driver Assistance System”, The GoodheartWillcox Company Publisher, 2024.

REFERENCE BOOKS:

1. Automobile Electrical & Electronic Equipments - Young, Griffitns - Butterworths, London.
2. Automobile Electrical & Electronic Systems – Tom Denton, Allied Publishers Pvt. Ltd.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2:	Fundamentals of automotive electronics, The 4 Stroke cycle, Engine Control, Ignition System-Spark Plug, High-Voltage circuit and Distribution, Spark Pulse generation, Ignition Timing, Diesel Engine, Drive train-Transmission, Drive Shaft, Differential, Suspension, Brakes, Steering System.
2	Week 3-5:	Understanding of various sensors and Actuators such as Air Flow Rate SensorIndirect measurement of Mass Air Flow, Engine crankshaft angular position sensor- Magnetic Reluctance Position Sensor, Hall-effect Position Sensor, Throttle Angle Sensor, Temperature Sensor, Automotive engine control actuators- Fuel Injection, Exhaust Gas Recirculation actuator, Variable Value Timing.
3	Week 6-7:	Understanding of An Electronic Engine Control System, Definition of General Terms, Engine Performance Terms, Electronic fuel control system, Engine control sequence-open loop and closed loop, Electronic Ignition.
4	Week 8-10:	Understanding of Digital engine control Features, Control Modes for Speed Control, Engine speed sensor, Timing sensor for ignition and fuel delivery,

		Electronic ignition control-closed loop ignition timing, Integrated Engine Control System. Study of Vehicle motion control which includes Typical Cruise control system, Digital cruise control, Speed Response Curves, Throttle Actuator Cruise control electronics, Stepper motor-based actuator.
5	Week 11-12:	Study of Antilock Braking System(ABS), Electronic suspension system, Advanced Driver Assistance System.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance the understanding of Automotive Electronics concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
5	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies

6. Assessment Details (both CIE and SEE) Continuous Internal Evaluation:

The minimum CIE marks requirement is 40% of maximum marks in each component. **CIE Split up**

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks =(A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

1. Question paper pattern will be ten questions. Each question is set for 20 marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Automotive Fundamentals	Grasp the fundamentals of automotive electronics, Engine Control, Ignition System-Spark Plug, High-Voltage circuit and Distribution, Spark Pulse generation, Ignition Timing, working of 4 Stroke cycle, Diesel Engine, Drivetrain-Transmission, Drive Shaft, Differential, Suspension, Brakes, Steering System.
2	Sensors and Actuators	Understanding the working of various sensors and Actuators such as Air Flow Rate Sensor, Indirect measurement of Mass Air Flow, Engine crankshaft angular position sensor, Automotive engine control actuators and understanding of Digital engine control Features, Control Modes for Speed Control, Engine speed sensor, Timing sensor for ignition and fuel

		delivery, Electronic ignition control-closed loop ignition timing, Integrated Engine Control System.
3	Electronic Engine control	Studying of an Electronic Engine Control System, Definition of General Terms, Engine Performance Terms, Electronic fuel control system, Engine control sequence-open loop and closed loop, Electronic Ignition.
4	Digital engine Control Systems, Vehicle Motion Control	Studying of Digital engine control Features, Control Modes for Speed Control, Engine speed sensor, Timing sensor for ignition and fuel delivery, Electronic ignition control-closed loop ignition timing,
		Integrated Engine Control System, Vehicle motion control which includes Typical Cruise control system, Digital cruise control, Speed Response Curves, Throttle Actuator Cruise control electronics, Stepper motor-based actuator, Vacuum operator actuator, Antilock Braking System(ABS), Electronic suspension system, Electronic steering control..
5	Advanced Driver Assistance System.	Understanding of ADAS Features- Advanced Cruise control, Adaptive Light control, Blind spot detection, Lane Departure warning, Lane keeping Assistance, Driver Alert system, Cross Traffic Alert, Parking Assistant systems, Night Vision.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	
M23BEC604D.1	**Understand the basics of automotive electronics, 4 stroke engine, Diesel engine, sensors and actuators-it's working**.
M23BEC604D.2	**Apply** the fundamentals of automotive electronics for the understanding of **Electronic Engine Control** Systems**,** Digital Engine Control Systems and Vehicle motion control.
M23BEC604D.3	**Apply** the automotive electronics for the understanding of Advanced Driver Assistance Systems.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC604D.1	2	2	-	-	-	-	-	-	-	-	-	-	2	-
M23BEC604D.2	2	2	-	-	-	-	-	-	-	-	-	-	2	-
M23BEC604D.3	3	2	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC604D	2.33	2	-	-	-	-	-	-	-	-	-	-	2.33	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	Total
Module 1	**10**			**10**
Module 2	**10**			**10**
Module 3		**10**		**10**

Module 4		**10**		**10**
Module 5			**10**	**10**
Total	**20**	**20**	**10**	**50**

Semester End Examination (SEE)

	CO1	**CO2**	**CO3**	**Total**
Module 1	**20**			**20**
Module 2	**20**			**20**
Module 3		**20**		**20**
Module 4		**20**		**20**
Module 5			**20**	**20**
Total	**40**	**40**	**20**	**100**

10. Future with this Subject:

The future of Automotive Electronics holds exciting possibilities across various domains, driven by advancements in technology and expanding applications. Here are some key trends,

- **Advanced Driver Assistance Systems (ADAS) and Autonomous Driving:**
  The move from partial automation (Level 2) to full automation (Level 5) will require significant advancements in automotive electronics. This includes more sophisticated sensors (LiDAR, radar, cameras), AI-based decision-making systems, and robust ECUs (Electronic Control Units).
- **Electric Vehicles (EVs) and Power Train Electronics:**
  The development of more efficient inverters, electric motors, and controllers will be essential for the performance and sustainability of EVs.
- **Collision Avoidance Systems:**
  Electronics will play a critical role in preventing accidents by detecting potential collisions and automatically taking evasive actions, such as braking or steering away from obstacles.

6th Semester	**Project Work (PW)** **MAJOR PROJECT PHASE-I**	**M23BEC605**

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Understanding Research Methodology	Basic understanding of research methods, gained from prior courses in engineering mathematics and introductory project work.
2	Conducting a Literature Survey	Familiarity with academic databases, journals, and research papers; understanding of the subject matter from core courses.
3	Defining a Problem Statement	Critical thinking and analytical skills, developed through previous coursework in related engineering disciplines.
4	Multidisciplinary Collaboration	Basic knowledge of related disciplines (e.g., Mechanical students should have a basic understanding of Electronics, etc.).
5	Technical Communication	Writing technical reports and presenting technical content

2. Competencies

S/L	Competency	KSA Description
1	Research Skills	**Knowledge:** Understanding of advanced research methods and tools. **Skill:** Ability to identify, review, and synthesize relevant literature. **Attitude:** Commitment to thorough investigation and unbiased analysis.
2	Problem Identification	**Knowledge:** Deep understanding of the chosen topic area. **Skill:** Capability to define and frame a research problem effectively. **Attitude:** Critical and innovative thinking.

3	Technical Writing	**Knowledge:** Familiarity with technical writing conventions. **Skill:** Proficiency in drafting structured, clear, and concise reports. **Attitude:** Attention to detail and accuracy in documentation.
4	Presentation Techniques	**Knowledge:** Understanding of effective communication strategies. **Skill:** Ability to create and deliver engaging presentations. **Attitude:** Confidence and poise in public speaking.

3. Project Timeline

S/L	Timeline	Description
1	Week 1-2	Introduction to research methods and tools; exploring literature review techniques.
2	Week 3-4	Initiating literature survey; identifying key research papers and sources.
3	Week 5-6	Analysis and synthesis of literature; identifying gaps and formulating insights.
4	Week 7-8	Defining the problem statement based on literature findings.
5	Week 9-10	Drafting the initial report; focusing on structure and content.
6	Week 11-12	Finalizing the report and preparing the presentation.
7	Week 13-14	Presentation rehearsal; peer review and feedback sessions
8	Week 15	Submission of the final report and formal presentation.

4. Course Objectives

- To enable students to conduct a comprehensive literature survey related to their project topic.
- To guide students in defining a clear and feasible problem statement.
- To develop skills in report writing, summarizing findings, and formal presentation.

5. Assessment Details (both CIE and SEE) CIE procedure for Project Work Phase-I:

(1) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide. The CIE marks awarded for the project work, shall be based on the evaluation of the project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

(2) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

SEE procedure for Project Work Phase-I: There shall be no SEE.

6. Learning Objectives

S/L	Learning Objectives	Description
1	Understand the process of conducting a literature survey.	Students will gain expertise in identifying and reviewing relevant research literature.
2	To formulate a research problem statement.	Students will learn to define a research problem that is clear, concise, and researchable.

3	To enhance technical writing and presentation skills.	Students will develop the ability to draft detailed reports and present their findings effectively.

7. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC605.1	Conduct a comprehensive literature survey and synthesize key findings.
M23BEC605.2	Define a research problem statement based on literature review.
M23BEC605.3	Develop and present a well-structured project report.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC605.1														
M23BEC605.2														
M23BEC605.3														
M23BEC605														

8. Future with this Subject

This phase equips students with essential research and analytical skills, forming the foundation for the practical work in Phase II. It also enhances their technical writing and presentation abilities, which are critical for their final year projects and professional careers.

.6th Semester	Professional Core Course Laboratory (PCL) VLSI LABORATORY	M23BECL606

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Electronics	• Understanding of fundamental electronic components such as resistors, capacitors, inductors, diodes, and transistors.
2	Digital Logic Design	• Familiarity with basic logic gates (AND, OR, NOT, NAND, NOR, XOR, XNOR) and their functions. • Understanding of combinational logic circuits (e.g., multiplexers, adders) and sequential circuits (e.g., flip-flops, counters).
3	Analog Electronics	• Knowledge of analog components such as operational amplifiers and transistors.
4	Hardware Description Languages	• Proficiency in Hardware Description Languages (HDLs) such as VHDL or Verilog for designing and simulating digital circuits. • Understanding of tools and techniques for synthesizing HDL code into gate-level designs.

2. Competencies

S/L	Competency	KSA Description

1	Combinational logic	**Knowledge:** Understanding that sequential circuits use memory elements (such as flip-flops) to store state information, which affects their output based on both current inputs and past states. **Skills:** Ability to design combinational logic circuits using standard logic gates, including the creation of schematic diagrams and circuit layouts **Attitudes:** Applying logical reasoning and systematic analysis to solve combinational logic problems and optimize circuit designs.
2	Sequential logic	**Knowledge:** Concepts of plane stress, inclined section stresses, principal stresses, and maximum shear stresses. Mohr's circle for plane stress. **Skills:** Ability to design sequential circuits using flip-flops, registers, and counters, and to implement state machines for various applications. **Attitudes:** A logical approach to solving design challenges, troubleshooting issues, and optimizing circuit performance
3	Hardware Description Languages Basics	**Knowledge:** Understanding the role of HDLs in digital design, including their use in modelling, simulation, synthesis, and verification of digital systems. **Skills:** Ability to write efficient, readable, and maintainable HDL code for both combinational and sequential circuits **Attitudes:** Careful review of HDL code, test benches, and simulation results to avoid errors and ensure correctness

3. Syllabus

VLSI LABORATORY SEMESTER – VI			
Course Code	**M23BECL606**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**0:0:2:0**	SEE Marks	**50**
Total Number of Lecture Hours	**12**	Total Marks	**100**
Credits	**01**	Exam Hours	**03**

Course Objectives:

1. Design, model, simulate and verify CMOS digital circuits.
2. Design layouts and perform physical verification of CMOS digital circuits.
3. Perform ASIC design flow and understand the process of synthesis, synthesis constraints and evaluating the synthesis reports to obtain optimum gate level netlist.

4. Perform RTL-GDSII flow and understand the stages in ASIC design Experiments can be conducted using any of the following or equivalent design tools: Cadence/Synopsis/Mentor Graphics/Micro wind

Part — A Analog Design	
Sl. No	**Experiments**
1.	Design an Inverter with given specifications, completing the design flow mentioned below: Draw the schematic and verify the following: i) DC Analysis ii) Transient Analysis Draw the Layout and verify the DRC
2.	Design a NAND gate with the given specifications, completing the design flow mentioned below: Draw the schematic and verify the following: i) DC Analysis ii) Transient Analysis Draw the Layout and verify the DRC
3.	Design a common source and common drain amplifier with the given specifications, completing the design flow mentioned below: Draw the schematic and verify the following: i) DC Analysis ii) Transient Analysis Draw the Layout and verify the DRC
4.	Design an operational amplifier with the given specifications, completing the design flow mentioned below: a. Draw the schematic and verify the following: i) DC Analysis ii) Transient Analysis b. Draw the Layout and verify the DRC
Part — B Digital Design	
1.	4-Bit Adder a. Write Verilog Code b. Verify the Functionality using Test-bench c. Synthesize the design by setting proper constraints and obtain the netlist. d. From the report generated identify the Critical path, Maximum delay, Total number of cells, Power requirement, and Total area required
2.	4-Bit Booth Multiplier a. Write Verilog Code b. Verify the Functionality using Test-bench c. Synthesize the design by setting proper constraints and obtain the netlist. From the report generated identify the Critical path, Maximum delay, Total number of cells, Power requirement and Total area required
3.	JK and MSJK Flip-Flop a. Write Verilog Code b. Verify the Functionality using Test-bench c. Synthesize the design by setting proper constraints and obtain the netlist. From the report generated identify Critical path, Maximum delay, Total number of cells, Power requirement and Total area required.
4.	4-Bit Synchronous counter a. Write Verilog Code b. Verify the Functionality using Test-bench c. Synthesize the design by setting proper constraints and obtain the netlist. From the report generated identify Critical path, Maximum delay, Total number of cells, Power requirement and Total area required

5.	4-Bit Universal Shift Register a. Write Verilog Code b. Verify the Functionality using Test-bench c. Synthesize the design by setting proper constraints and obtain the netlist. From the report generated identify Critical path, Maximum delay, Total number of cells, Power requirement and Total area required.

S/L	Open ended project
1	Design 4-bit adder with given specifications, completing the design flow mentioned below: Draw the schematic and verify the following: i) DC Analysis ii) Transient Analysis Draw the Layout and verify the DRC

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1	LAB Introduction
2	Week 2	Design an Inverter with a schematic and layout diagram. Verify an inverter DC and Transient analysis.
3	Week 3	Design a NAND gate with a schematic and layout diagram. Verify a NAND gate DC and Transient analysis.
4	Week 4	Design a common drain with a schematic and layout diagram. Verify a common drain DC and Transient analysis.
5	Week 5	Design a common source with a schematic and layout diagram. Verify a common source DC and Transient analysis.
6	Week 6	Design an operational amplifier with a schematic and layout diagram. Verify an operational amplifier DC and Transient analysis.
7	Week 7	Write Verilog Code for 4-Bit adder and Verify the Functionality using Test-bench.
8	Week 8	Write Verilog Code for 4-Bit Booth Multiplier and Verify the Functionality using Test-bench.
9	Week 9	Write Verilog Code for 4-bit Synchronous counter and Verify the Functionality using Test-bench.
10	Week 10	Write Verilog Code for JK and MSJK Flip-Flop and Verify the Functionality using Test-bench.
11	Week 11	Write Verilog Code for Universal Shift Register and Verify the Functionality using Test-bench.
12	Week 12	Lab Internals

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of Verilog concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with realworld competencies.
5	Laboratory Learning	Utilize the facilities available in the laboratories to understand the behavior of the materials by performing few experiments.

6. Assessment Details (both CIE and SEE)

- CIE marks for a practical course shall be 50 marks.
- The split up of CIE marks for record / journal and test to be split in the ratio 60:40
- Record write up for individual experiment will be evaluated for 10 Marks
- Total marks scored for record writing and conduction shall be scaled downed to 30 marks (60% of maximum marks)
- One test for 100 marks after the completion of the experiments at the end of the semester

Marks distribution for Experiment-based Practical Course for CIE

Sl. No.	Description	% of Marks	In Marks
1	Write-up, Conduction, result and Procedure	60%	60
2	Viva-Voce	40%	40
Total		**100%**	**100**

The Test marks should be scaled down to 20 marks (40% of the **maximum CIE Lab Marks (50)**)

Final CIE in Practical Course:

Marks distribution for Experiment based Practical Course for Final CIE

Sl. No.	Description	% of Marks	In Marks
1	Scaled Down marks of record / journal	60%of the maximum	30
2	Scaled Down marks of test	40%of the maximum	20
Total		**100%**	**50**

SEE for practical Course (Irrespective of Experiment or program-based):

5. SEE marks for practical course shall be 50 marks

Marks distribution for Experiment-based Practical Course for Final CIE

SL. No.	Description	% of Marks	Marks
1	Write-up, Procedure	20%	20
2	Conduction and result	60%	60
3	Viva-Voce	20%	20
Total		**100%**	**100**

6. SEE for practical course is evaluated for 100 marks and scored marks shall be scaled down to 50 marks.
7. Change of experiment/program is allowed only once and 20% marks allotted to the procedure/write-up part to be made zero.
8. Duration of SEE shall be 3 hours.

7. Learning Objectives

S/L	Learning Objectives	Description
1	Operational amplifier	Design and test an operational amplifier.
2	Amplifier	Design and test a common source and drain amplifier.
3	Combinational and Sequential circuits	Write Verilog code and test adder, flip-flops, counter and shift register

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BECL606.1	**Write** Verilog code for digital circuits and verify functionality using test benches
M23BECL606.2	**Analyze** synthesis reports to identify critical paths, maximum delay, total number of cells, power requirements, and total area required.
M23BECL606.3	**Design and simulate various CMOS schematics and layouts.**

M23BECL606.4	**Conduct** experiments either individually or in a team and present the corresponding outcomes and process both orally and written form.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BECL606.1	3	-	-	-	3	-	-	-	-	-	-	-	3	-
M23BECL606.2	-	3	-	-	3	-	-	-	-	-	-	-	-	3
M23BECL606.3	-	-	3	-	3	-	-	-	-	-	-	-	3	-
M23BECL606.4	-	-	-	-	-	-	-	-	3	-	-	-	-	3
M23BECL606	**3**	**3**	3	-	3	-	-	-	3	-	-	-	3	3

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	**Total**
Exp1	**10**	**10**	**20**	**10**	**50**
Exp2	**10**	**10**	**20**	**10**	**50**
Exp3	**10**	**10**	**20**	**10**	**50**
Exp4	**10**	**10**	**20**	**10**	**50**
Exp5	**10**	**10**	**20**	**10**	**50**
Exp6	**10**	**10**	**20**	**10**	**50**
Exp7	**10**	**10**	**20**	**10**	**50**
Exp8	**10**	**10**	**20**	**10**	**50**
Exp9	**10**	**10**	**20**	**10**	**50**
Exp10	**10**	**10**	**20**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	**Total**
Exp1	**20**	**20**	**40**	**20**	**100**

10. Future with this Subject:

- **Nanometer Technology:** Continued miniaturization with process nodes advancing beyond 3nm, enabling even more transistors on a single chip. This will lead to greater performance and power efficiency but will also pose new design and verification challenges.
- **3D Integration:** Increased use of 3D ICs and chip stacking technologies to improve performance and reduce footprint.
- **Design Automation:** Integration of AI and machine learning into EDA tools for better design automation, optimization, and predictive analysis.
- **Hardware Security:** Design and implementation of VLSI circuits with built-in security features to protect against attacks like side-channel attacks and hardware Trojans.

6th Semester	Ability Enhancement -V(AE-V) PYTHON PROGRAMMING FOR ELECTRONICS AND COMMUNICATION	M23BEC607A

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Fundamentals of programming	Understanding fundamental programming concepts such as variables, data types, control structures (if statements, loops), functions, and basic algorithms is crucial.
2	Data Analysis	Ability to visualize data using tools like SciPy, NumPy, and Matplotlib helps understand the data better and communicate results.
3	Programming Skills	Python: Libraries like NumPy, Pandas, Scikit-learn, Tensor Flow, and PyTorchare essential. Basic Algorithms and Data Structures: Understanding basic data structures (like lists, dictionaries, and arrays) and algorithms (like sorting and searching) help implement the experiments efficiently.
4	Tools and Frameworks	Integrated Development Environments (IDEs), Familiarity with tools like Jupyter Notebook or PyCharm can enhance productivity.
5	Previous courses	Knowledge and theory concepts of basic Electronics related subjects like signal processing control systems, communication systems, information theory coding, image processing, etc is essential to implement the experiments.

2. Competencies

S/L	Competency	KSA Description
1	Flow control Statements while design the electronics experiments	**Knowledge:** Students should be able to identify, define, and proficiency in various Syntax, Decision making, loop construction, error debugging, flow control analysis, library functions. **Skills:** Utilizing the syntax and library functions required to write a program. Ability to analyze the flow control statement. **Attitudes:** Methodical approach to problem-solving, Programming and Simulation Skills, Critical Thinking.
2	Implementation of Electronics experiments in Python software	**Knowledge:** Proficiency in various types of control systems, signals and systems, communication, image processing, mathematical formulae, Error debugging. **Skills:** Utilize the courses concepts and apply mathematical formulae and knowledge of coding to build the experimental design. **Attitudes:** Methodical approach to problem-solving, Programming Skills, Critical Thinking, Designing Skills.
3	Hands on Experience	**Knowledge:** Practical experience in building simple circuits and programming them. **Skills:** Working on projects, and experimenting with different technologies, devices, and techniques emerging regularly. **Attitudes:** Commitment to lifelong learning and staying updated with the latest developments in Electronics and communication technology.

4	Debugging and Verification	**Knowledge:** Debugging and verification techniques, tools, and methodologies. **Skills:** Debug and verify experiments by using simulation, emulation, and prototyping and compare with python results. **Attitudes:** Attention to detail, persistence, and analytical thinking.

3. Syllabus

Python Programming for Electronics and Communication SEMESTER – VI			
Course Code	**M23BEC607A**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**0:0:2:0**	SEE Marks	**50**
Total Number of Lecture Hours	**12 sessions**	Total Marks	**100**
Credits	**01**	Exam Hours	**03**

Course Objectives:

1. To understand the problems in ECE courses and implement by using Python.
2. Design essential problem analysis calculations relevant to engineering.
3. To gain knowledge about ECE courses like Control systems, signal processing, image processing, communication, etc., and their implementation in Python.
4. To create new Python programming tools like SciPy, NumPy, and Matplotlib and design in the courses of ECE.

Execute the following experiments by using IDLE software or Pycharm, Jupiter, Spyder etc.

Signal processing

1. Write a program and execute low pass and high pass FIR filters
2. Write a program to eliminate the noise in the ECG signal by using FFT transforms.
3. Write a program to convert a given image to its grayscale pattern and resize the same.
4. Write a program to generate the magnitude response of an image using FFT transform.

Control Systems

5. Write a program to generate a root locus and Bode plot for any closed loop systems.
6. Write a program to execute the PID Controller for any transfer function.

Communication systems

7. Write a program to implement the sampling theorem and its reconstruction for a signal.
8. Write a program to generate ASK, FSK, and PSK waveforms.

Analog and Digital Electronics

9. Write a program to implement an Astable multivibrator.
10. Write a program to implement full adders and full subtractors.

TEXTBOOKS:

1. Python for Electrical and Computer Engineering" by J. N. Reddy, 2017.
2. Hands-On Electronics: A Practical Introduction to Analog and Digital Circuits by Daniel M. Kaplan and Christopher G. White, 2003
3. Practical Electronics for Inventors, by Paul Scherz, Simon Monk, 2013.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-3: Signal processing	Using signals tools and resources, it can effectively analyze and process signals in Python, making it a powerful platform for both learning and practical applications in signal processing.
2	Week 4-6: Control Systems	Using control tools and resources, we can model, analyze, and design control systems effectively in Python.

3	Week 8-11: Communication Systems	Python is a powerful tool for analyzing, simulating, and implementing communication systems. With its extensive libraries and ease of use, Python is well-suited for tasks such as signal modulation, demodulation, error analysis, and more.
4	Week 7-8: Image processing	Image processing in Python is a broad field encompassing tasks such as image enhancement, filtering, segmentation, and feature extraction. Python's rich ecosystem of libraries makes it a powerful tool for these tasks.
5	Week 9-12: Analog and Digital Electronics	Python can be a valuable tool for working with both analog and digital electronics through simulation, analysis, and educational purposes. While Python itself isn't used for direct circuit design or physical hardware manipulation, it can be employed to simulate circuits, analyze signal behaviors, and design algorithms related to electronics.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of Verilog concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with real world competencies.
5	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
6	Laboratory Learning	Utilize the facilities available in the laboratories to understand the behavior of the materials by performing few experiments.

6. Assessment Details (both CIE and SEE) Continuous Internal Evaluation:

The minimum CIE marks requirement is 40% of maximum marks in each component. **CIE Split up**

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks = (A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examination:

1. Question paper pattern will be ten questions. Each question is set for 20 marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Signal processing	Learn the basic principles of machine learning, including supervised, unsupervised, and reinforcement learning.
2	Control Systems	Study different types of algorithms like decision trees, support vector machines, neural networks, and clustering algorithms.

3	Communication Systems	Learn what decision trees are and how they work, including their structure (nodes, branches, leaves) and how decisions are made. Understand how decision trees are built using algorithms that split data based on feature values to make predictions.
4	Image processing	When learning image processing using Python, the objectives are typically to understand fundamental concepts, master Python tools for image manipulation, and apply these skills to real-world problems.
5	Analog and Digital Electronics	When learning analog and digital electronics using Python, the objectives typically focus on understanding fundamental concepts, applying Python tools for simulation and analysis, and developing practical electronic design and analysis skills.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC607A.1	**Explain fundamental concepts of signal processing, control systems, communication systems, image processing, analog and digital electronics.**
M23BEC607A.2	**Implement programs for signal processing, control systems, communication systems, image processing, analog and digital electronics in Python software,**
M23BEC607A.3	**Present experimental corresponding outcomes either individually or in the team.**

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC607A.1	3	3	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC607A.2	3	3	-	-	3	-	-	-	3	-	-	-	3	-
M23BEC607A.3	-	-	-	-	-	-	-	-	-	3	-	-	-	-
M23BEC607A	**3**	**3**	**-**	**-**	**3**	**-**	**-**	**-**	**3**	**3**	**-**	**-**	**3**	**-**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	Total
Total	**15**	**15**	**20**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	Total
Total	**30**	**30**	**40**	**100**

10. Future with this Subject:

- **Advanced Algorithms:** Python will continue to leverage advanced algorithms for simulating complex electronic and communication systems, integrating machine learning for predictive modeling and optimization.
- **Cloud-Based Simulation:** Cloud-based platforms will provide scalable resources for large-scale simulations, with Python scripting facilitating remote access and automation of simulations.

- **AI-Driven Design:** AI algorithms integrated with Python will assist in automating the design and optimization of electronic circuits and communication systems, leading to more efficient and innovative designs.
- **Adaptive Systems:** Machine learning models will enable adaptive communication systems that adjust parameters in real time based on environmental conditions and user requirements.
- **Edge AI:** Python will play a crucial role in developing AI applications at the edge, enabling devices to perform local processing and intelligent decision-making without relying on centralized cloud systems.

6th Semester	Ability Enhancement -V(AE-V) BASICS OF FPGA	M23BEC607B

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic understanding of digital logic	Familiarity with digital circuits, Boolean algebra, and logic gates.
2	Programming skills	Knowledge of programming languages like VHDL (VHSIC-HDL) or Verilog, which are used to describe digital designs.
3	Digital design tools	Familiarity with digital design tools like – IDEs (Integrated Development Environments) like Xilinx Vivado Simulation tools like Model Sim or Vivado Simulator. Synthesis tools like Xilinx Vivado HLS.
4	Mathematics	Basic understanding of mathematical concepts like binary numbers and algebra.
5	Problem-solving skills	Ability to analyze problems, break them down into smaller components, and develop creative solutions.

2. Competencies

S/L	Competency	KSA Description
1	Digital Logic Design	**Knowledge:** Digital circuits, Boolean algebra, logic gates, flip-flops, counters, and arithmetic circuits. **Skills:** Design, analyze, and implement digital circuits using VHDL or Verilog. **Attitudes:** Attention to detail, logical thinking, and problem-solving.
2	FPGA Architecture	**Knowledge:** FPGA architecture, logic blocks, memory, interconnects, and I/O interfaces. **Skills:** Understand and optimize FPGA resource utilization. **Attitudes:** Curiosity, analytical thinking, and resourcefulness.
3	VHDL/Verilog Programming	**Knowledge:** VHDL or Verilog programming languages, syntax, and semantics. **Skills:** Write efficient, synthesizable code. **Attitudes:** Attention to detail, patience, and persistence.
4	System Integration	**Knowledge:** Digital system integration, interfaces, and communication protocols. **Skills:** Integrate digital systems with external components. **Attitudes:** System thinking, collaboration, and adaptability.
5	Debugging and Verification	**Knowledge:** Debugging and verification techniques, tools, and methodologies. **Skills:** Debug and verify digital systems using simulation, emulation, and prototyping. **Attitudes:** Attention to detail, persistence, and analytical thinking.

3. Syllabus

BASICS OF FPGA SEMESTER – VI			
Course Code	**23BEC607B**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**0:0:2:0**	SEE Marks	**50**
Total Number of Lecture Hours	**12 Lab sessions**	Total Marks	**100**
Credits	**01**	Exam Hours	**03**

Course Objectives:

1. Design combinational and sequential digital circuits
2. Model Combinational and sequential digital circuits by HDL
3. Design and model digital circuits with HDL at behavioral, structural, and RTL Levels
4. Develop test benches to simulate combinational and sequential circuits.
5. Understand the FPGA Architecture
6. Implementation of the combinational and sequential digital circuits in FPGA
7. Understand configuring and interfacing of FPGA board with other hardware boards.

	List of Experiments
1.	Write HDL code to realize parallel adder or subtractor.
2.	Write HDL code to realize 4 bit array multiplier using
3.	Write a HDL code to describe the functions of SISO and SIPO shift registers using D flip-flop.
4.	Write a HDL code to describe the functions of PISO and PIPO shift registers using D flip-flop.
5.	Develop the HDL code to design a 4 bit synchronous binary counter.
6.	Develop the HDL code to design a 4 bit asynchronous binary counter.
7.	Write a HDL code to Implement a 4 bit synchronous BCD counter.
8.	Write a HDL code to Implement a 4 bit synchronous BCD counter.
9.	Write a HDL code to Implement a finite state machine using sequential circuit.
10.	Write a HDL code to design a MIPS processor.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1 Introduction to the lab	Introduction to the field programmable gate array and digital design with FPGA
2	Week 2-3: Experiments 1-2	Design and develop HDL code to realize combinational circuits on FPGA kit using Xilinx Vivado Platform.
3	Week 4-7: Experiments 3-6	Design and develop HDL code to realize sequential circuits such as shift registers and counters.
4	Week 8-10: Experiments 7-9	Design and develop HDL code to realize sequential circuits such as counters and state machine on FPGA kit using Xilinx Vivado Platform.
5	Week 11-12: Experiments 10 IA	Develop HDL code to Implement a finite state machine using sequential circuit and design a MIPS processor

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of FPGA concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with realworld competencies.
5	Laboratory Learning	Utilize the facilities available in the laboratories to understand the implementation on FPGA by performing experiments.

6. Assessment Details (both CIE and SEE)

CIE for Program Based Ability Enhancement Course:

Internal test for laboratory course with software experiments shall be conducted for a total of 100 mark at the end the semester and the assessment pattern is

Marks distribution for Program based Practical Course for CIE

Sl. No.	Description	% of Marks	Marks
1	Observation, write-up, Algorithm / program / execution	80% of the maximum	80
2	Viva-Voce	20% of the maximum	20
	Total	100%	100

Marks scored by the student for100 are scaled down to 50marks.

SEE for practical Course:

SEE marks for practical course shall be 50 marks.

Marks distribution for Experiment based Practical Course for Final SEE

SL. No.	Description	% of Marks	Marks
1	Write-up, Procedure	20%	20
2	Conduction and result	60%	60
3	Viva-Voce	20%	20
Total		**100%**	**100**

1. SEE for practical course is evaluated for 100 marks and scored marks shall be scaled down to 50 marks.
2. Change of experiment/program is allowed only once and 20% marks allotted to the procedure/writeup part to be made zero.
3. Duration of SEE shall be 3 hours.

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding basic FPGA architecture	Realising digital circuits on FPGA kit requires understanding of FPGA architecture, I/O configurations and Interfacing of Hardware architecture
2	Understanding HDL syntax	To develop code to realise any digital circuit it is required to learn Hardware Description Language.
3	Applying the knowledge of digital design	Combinational circuits such as adders and Sequential circuits such Flip-counters and registers are required.
4	Analysing state machines to write HDL code.	Knowledge of state machine is necessary to design complex digital systems.
5	Understanding Xilinx vivado environment	Xilinx vivado environment or any IDE is a platform on which HDL code is compiled. It helps us to design and test any digital system through simulation before it could be realized on FPGA.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC607B.1	**Apply** the knowledge of digital system design and HDL to write code for combinational circuits such as adders and sequential circuits such as shift registers, counters, finite state machine and MIPS processor.
M23BEC607B.2	**Implement** the compiled code on FGPA board and check its functionality by verifying the truth table.
M23BEC607B.3	**Present** experimental results/process both orally and in written form.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC607B.1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC607B.2	3	-	-	3	3	-	-	-	-	-	-	-	-	3
M23BEC607B.3	3	-	-	-	-	-	-	-	-	3	-	-	-	-
M23BEC607B	**3**	**-**	**-**	**3**	**3**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	**Total**
Expt-1	15	20	15	50
Expt-2	15	20	15	50
Expt-3	15	20	15	50
Expt-4	15	20	15	50
Expt-5	15	20	15	50
Expt-6	15	20	15	50

Expt-7	15	20	15	50
Expt-8	15	20	15	50
Expt-9	15	20	15	50
Expt-10	15	20	15	50
Total	15	20	15	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	**Total**
Experiment	15	20	15	50

10. Future with this Subject:

The "Basics of FPGA" course can provide students with a comprehensive understanding of FPGA fundamentals and their applications in cutting-edge technologies. Field-Programmable Gate Arrays (FPGAs) play a vital role in various industries. Here are some potential developments that may shape the future of this course:

- **Increased focus on AI and Machine Learning:** FPGAs are being used to accelerate AI and ML workloads, so the course may cover more topics related to AI-optimized FPGA design.
- **Advanced Digital Signal Processing (DSP):** FPGAs are widely used in DSP applications, so the course may include more advanced DSP topics and case studies.
- **Hands-on Experience with Real-World Projects:** The course may focus more on practical, realworld projects to help students develop problem-solving skills and prepare them for industry challenges.
- **Coverage of Emerging FPGA Technologies:** The course may explore new FPGA architectures, such as 3D FPGAs, and emerging applications like edge computing and autonomous vehicles.

6th Semester	Ability Enhancement -V(AE-V) EXPERIENTIAL LEARNING LAB	M23BEC607C

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Electronics	Basic understanding of voltage, current, resistance, and how to use a breadboard, resistors, LEDs, and other basic components
2	Programming Basics	Understanding how to use the Integrated Development Environment (IDE) for writing, compiling, and uploading code
3	Basics of communications	Familiarity with basics of communications
4	Communication Protocols	For interfacing with sensors and modules.
5	Basics of circuits	To check connections, measure voltages, and diagnose circuit issues, Ability to troubleshoot circuits, code, and communication issues

2. Competencies

S/L	Competency	KSA Description
1	UART and Ethernet	**Knowledge:** Understanding of UART and ethernet as a method of asynchronous serial communication **Skills:** Ability to correctly connect Arduino to other UART-compatible devices, ensuring proper cross-connection of TX and RX pins **Attitudes:** Careful setup of baud rates and connections to ensure smooth communication.
2	I2C and SPI Communication	**Knowledge:** Understanding of the I2C and SPI communication protocol, including concepts like master-slave architecture, addressing, start and stop conditions, ACK/NACK, and data transmission. **Skills:** Ability to correctly wire I2C devices to the Arduino, ensuring proper connections for SDA and SCL lines, and selecting appropriate pull-up resistors if needed **Attitudes:** Careful configuration of I2C AND SPI addresses and wiring to avoid conflicts and ensure reliable communication
3	WIFI and Bluetooth	**Knowledge:** Understanding of Wi-Fi and Bluetooth communication, including concepts like SSID, encryption (WPA2, WEP), IP addressing, and the basics of TCP/IP and UDP protocols **Skills:** Ability to correctly wire and configure Wi-Fi modules, including power supply considerations and proper connections to the Arduino **Attitudes:** implementing secure connections and protecting network access, particularly when handling sensitive data
4	RF and NFC communication	**Knowledge:** Understanding the principles of RF communication, including modulation techniques (AM, FM), frequency bands, and the difference between licensed and unlicensed frequency bands.**Skills:** Ability to correctly connect RF modules to the Arduino, ensuring proper power supply, wiring, and antenna connections **Attitudes:** to experiment with different configurations and settings to achieve reliable RF communication, especially in challenging environments.
5	Arduino Projects	**Knowledge:** Knowledge of Arduino hardware, its microcontroller (e.g., ATmega328P on the Arduino Uno), pin configuration, and power requirements **Skills:** Ability to write and debug code for Arduino, including using libraries and integrating various sensors and modules **Attitudes:** Debugging and troubleshooting without getting frustrated, understanding that trial and error is part of the process.

3. Syllabus

EXPERIENTIAL LEARNING LAB SEMESTER – VI			
Course Code	**M23BEC607C**	CIE Marks	**50**
Teaching Hours/Week(L:T:P:S)	**0:0:2:0**	SEE Marks	**50**
Total Number of Lecture Hours	**12 Lab sessions**	Total Marks	**100**
Credits	**01**	Exam Hours	**03**

Course Objectives:

1. Understand Basic Interfacing Techniques of various sensors and modules with the Arduino Uno, focusing on different communication protocols such as UART, I2C, SPI, Wi-Fi, Bluetooth, and Ethernet.
2. Develop Practical Skills in Sensor Integration Gain hands-on experience in connecting and programming ultrasonic, IR, and MPU6050 sensors with the Arduino Uno, and display real-time data on an LCD screen
3. Implement Data Storage Solutions to interface an SD card module with the Arduino Uno using SPI communication to store and retrieve data effectively.
4. Explore Wireless Communication Understand the concepts of wireless communication by interfacing the ESP8266 Wi-Fi module and HC-05 Bluetooth module with the Arduino Uno, enabling remote control and data exchange.

To realize the following experiments using Arduino and the **probable projects using Arduino** are listed below.

1	To interface the Arduino and a computer using UART protocol.
2	To interface network using Ethernet shield with Arduino using Ethernet communication
3	To Interface MPU6050 sensor with Arduino using I2C communication.
4	To Interface with SD card module with Arduino using SPI Communication
5	To Interface ESP8266 Module with Arduino Uno using WIFI Communication.
6	To design automated street lighting using Arduino
7	To design robotic arm using Arduino
8	To design home automation using Arduino
9	To design Weather station using Arduino
10	To design Home security system using Arduino
11	**Open ended experiment**: To send sensor data from arduino to MySQL

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-3: UART,Ethernet,I2C	Studying of Arduino architecture and pins with the interfacing of ultrasonic and IR sensor with the results are displayed in the LCD screen.
2	Week 4-6: SPI	Studying of interfacing Arduino with Ethernet shield, Interfacing MPU60650 sensor using I2CCommunication and with interfacing UART with Arduino to display data on monitor screen.
3	Week 7-8 WIFI and Bluetooth	Studying to interface SD card module with Arduino using SPI protocol.

4	Week 9-10 WIFI and Bluetooth, Projects	Studying to interface ESP8266 module with Arduino using WIFI Communication and HC05 Module using Bluetooth module.
5	Week 10-12: Projects related to Arduino	Projects related street lighting, robotic arm, home automation, weather station, home security system using arduino

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of Arduino architecture
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with real world competencies.
5	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
6	Laboratory Learning	Utilize the facilities available in the laboratories to understand the behavior of the materials by performing few experiments.

6. Assessment Details (both CIE and SEE)

The Test marks should be scaled down to 30marks (60% of the maximum Marks)

Laboratory Test: -B

CIE Split up for Test in Laboratory-based Ability Enhancement Course

SL. No.	Description	% of Marks	In Marks
1	Write-up, Conduction, result, and Procedure	60%	30
2	Viva-Voce	40%	20
Total		**100%**	**50**

The Test marks should be scaled down to 20marks (40% of the maximum Marks)

Final CIE for Laboratory-based Ability Enhancement Course

SL. No.	Description	% of Marks	In Marks
1	Scaled Down marks of record/journal-A	60% of the maximum	30
2	Scaled Down marks of test-B	40% of the maximum	20
Total		**100%**	**50**

Final CIE Marks =(A) + (B) Semester

End Examinations:

1. SEE marks for practical course shall be 50 marks

SL. No.	Description	% of Marks	Marks
1	Write-up, Procedure	20%	20
2	Conduction and result	60%	60
3	Viva-Voce	20%	20
Total		**100%**	**100**

2. SEE for practical course is evaluated for 100 marks and scored marks shall be scaled down to 50 marks.
3. Change of experiment/program is allowed only once and 20% marks allotted to the procedure/writeup part to be made zero.

Duration of SEE shall be 3 hours. **7.**

Learning Objectives

S/L	Learning Objectives	Description
1	UART and Ethernet	Understanding Communication Protocols UART Understand the fundamentals of UART communication, including asynchronous data transmission, baud rate, start/stop bits, and parity. Comprehend the basics of Ethernet communication, including the TCP/IP stack, IP addressing, MAC addresses, and the role of Ethernet in local area networks
2	I2C and SPI Communication	Understanding Communication Protocols Understand the principles of I2C communication, including the master-slave architecture, addressing, and the role of the SDA (data) and SCL (clock) lines. Comprehend the fundamentals of SPI communication, including the master-slave relationship, full-duplex data transmission, and the use of MOSI
3	WIFI and Bluetooth	Understanding Wireless Communication Protocols Understand the principles of Wi-Fi communication, including how it operates within the 2.4 GHz and 5 GHz frequency bands. Comprehend the fundamentals of Bluetooth communication, including how it operates within the 2.4 GHz ISM band.
4	RF and NFC communication	Understanding Communication Protocols Understand the principles of RF communication, including the basics of radio waves, frequency bands, modulation techniques (AM, FM), and the role of antennas
5	Projects related to Arduino	Projects associated with street lighting, robotic arm, home automation, Weather station, home security using Arduino

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC607C.1	Explain the fundamental concepts and working principles of sensors, ,and communication modules used with Arduino
M23BEC607C.2	Implement programs to interface various sensors and communication protocol with Arduino for specific tasks like monitoring and control.

M23BEC607C.3	Create network-based applications using different protocols for data exchange applications.
M23BEC607C.4	Conduct experiments either individually or in a team and present the corresponding outcomes and process both orally and in a written form.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC607C.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
M23BEC607C.2	-	3	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC607C.3	-	3	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC607C.4	-	-	-	-	3	-	-	-	3	-	-	-	3	-
M23BEC607C	**3**	**3**	3		3	-	-	-	3	-	-	-	3	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	**Total**
Expt-1	20	10	10	10	50
Expt-2	20	10	10	10	50
Expt-3	20	10	10	10	50
Expt-4	20	10	10	10	50
Expt-5	20	10	10	10	50
Expt-6	20	10	10	10	50
Expt-7	20	10	10	10	50
Expt-8	20	10	10	10	50
Expt-9	20	10	10	10	50
Expt-10	20	10	10	10	50
Total	20	10	10	10	**50**

10. Future with this Subject:

- **5G and Beyond**: As 5G technology becomes more widespread, Arduino could integrate 5G modules, enabling ultra-fast, low-latency communication for IoT devices and other applications. This could open up new possibilities for real-time data processing, remote monitoring, and control in critical applications like autonomous vehicles, smart cities, and industrial automation.
- **Built-In Encryption and Authentication:** With the increasing importance of cybersecurity, future Arduino boards might come with built-in hardware support for advanced encryption algorithms and secure key storage. This would help secure communication protocols like Wi-Fi, Bluetooth, and RF against unauthorized access and cyber threats
- **Edge AI and Machine Learning:** Arduino boards could be equipped with AI and machine learning capabilities, allowing them to process data locally and make decisions in real time. This would reduce reliance on cloud computing and improve the efficiency and responsiveness of communication
- **Cognitive Radio Networks: future** Arduino platforms might support cognitive radio networks, where devices dynamically adapt their communication protocols based on real-time spectrum analysis. This could optimize the use of available frequencies, reducing interference and improving the reliability of wireless communication.
- **Simplified Communication Libraries:** Future Arduino IDEs may include more intuitive and powerful libraries for communication protocols, making it easier for developers to implement complex communication tasks with minimal coding. This would lower the barrier to entry for beginners and accelerate prototyping for advanced users.

6th Semester	Ability Enhancement Course –V (AE) SENSORS and ACTUATORS	M23BEC607D

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Knowledge of Electrical Circuits	• A strong foundation in electrical circuit theory, including Ohm's Law, Kirchhoff's laws, and the basic concepts of AC/DC circuits.
2	Basic Knowledge of Analog and Digital Electronics	• Familiarity with the principles of analog and digital electronics, including semiconductor devices, logic gates, amplifiers, and ADC/DAC conversion.
3	Understanding of Sensor Principles	• Knowledge of the basic operating principles of sensors, including types of sensors (thermal, mechanical, optical, etc.), their characteristics, and applications.
4	Problem-Solving Skills	• Ability to apply engineering mathematics and physics principles to design and analyze sensor and actuator systems.

2. Competencies

S/L	Competency	KSA Description
1	Electrical Circuits	**Knowledge:** Understand the principles of electrical circuits, including Ohm's Law, Kirchhoff's laws, and AC/DC circuits. **Skills:** Analyze and solve circuit problems. **Attitudes:** Value the importance of strong circuit analysis skills in sensor and actuator design.
2	Sensor Principles	**Knowledge:** Understand the operating principles of various sensors (thermal, mechanical, optical, etc.) and their characteristics. **Skills:** Select and apply appropriate sensors for specific applications. **Attitudes:** Appreciate the diverse applications of sensors in modern technology.
3	Actuator Systems	**Knowledge:** Familiarity with different types of actuators (pneumatic, hydraulic, and electrical) and their control mechanisms. **Skills:** Design and implement actuator systems for various industrial applications. **Attitudes:** Recognize the significance of actuators in automation and control systems.
4	Smart Sensors and Interfaces	**Knowledge:** Understand the fundamentals of smart sensors, including data acquisition, processing, and communication interfaces. **Skills:** Integrate smart sensors into broader systems for enhanced functionality. **Attitudes:** Value the role of smart sensors in advancing automation and IoT.
5	Sensor and Actuator Applications	**Knowledge:** Understand the real-world applications of sensors and actuators in fields such as automotive, aerospace, and environmental monitoring. **Skills:** Apply knowledge to design systems for specific application needs. **Attitudes:** Demonstrate curiosity and innovation in the application of sensor and actuator technologies.

3. Syllabus

SENSORS and ACTUATORS SEMESTER–VI			
Course Code	**M23BEC607D**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**0:0:2:0**	SEE Marks	**50**
Total Number of Lecture Hours	**12 Lab sessions**	Total Marks	**100**
Credits	**01**	Exam Hours	**03**

Course Objectives:

1. Understanding basic laws and phenomena on which operation of sensors and actuators - transformation of energy.
2. Create analytical design and development solutions for sensors and actuators.
3. To know the basic laws of behavior of sensors and actuators.
4. To able to know about the Standards for Smart Sensor Interface
5. Analyze the development and application of sensors and actuators.

Sl. No.	To realize the following Experiments using Arduino and Raspberry-Pi.
1	To sense the Available Networks Using Arduino.
2	Measure the Distance Using Ultrasonic Sensor and Make Led Blink Using Arduino.
3	To detect the Vibration of an Object Using Arduino
4	Connect with the Available Wi-Fi Using Arduino.
5	Sense a Finger When it is Placed on Board Using Arduino.
6	Temperature Notification Using Arduino-Uno.
7	LDR to Vary the Light Intensity of LED Using Arduino.
8	MySQL Database Installation in Raspberry Pi.
9	SQL Queries by Fetching Data from Database in Raspberry-Pi
10	Switch Light On and Off Based on the Input of user using Raspberry Pi.

Suggested Learning Resources:

Textbooks:

"Arduino Cookbook" by Michael Margolis and Brian Jepson

"Raspberry Pi Cookbook for Python Programmers" by Tim Cox

1. "Programming Arduino: Getting Started with Sketches" by Simon Monk

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2:	To sense the Available Networks Using Arduino. Measure the Distance Using Ultrasonic Sensor and Make Led Blink Using Arduino.
2	Week 3-4:	To detect the Vibration of an Object Using Arduino Connect with the Available Wi-Fi Using Arduino.
3	Week 5-6:	Sense a Finger When it is Placed on Board Using Arduino. Temperature Notification Using Arduino-Uno.
4	Week 7-8:	LDR to Vary the Light Intensity of LED Using Arduino. MySQL Database Installation in Raspberry Pi.
5	Week 9-10:	SQL Queries by Fetching Data from Database in Raspberry-Pi Switch Light On and Off Based on the Input of user using Raspberry Pi.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of Verilog concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Real-World Application	Discuss practical applications to connect theoretical concepts with real world competencies.

5	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
6	Laboratory Learning	Utilize the facilities available in the laboratories to understand the behavior of the materials by performing few experiments.

6. Assessment Details (both CIE and SEE)

CIE for Program Based Ability Enhancement Course:

Internal test for laboratory course with software experiments shall be conducted for a total of 100 mark at the end the semester and the assessment pattern is

Marks distribution for Program based Practical Course for CIE

Sl. No.	Description	% of Marks	Marks
1	Observation, write-up, Algorithm / program / execution	80% of the maximum	80
2	Viva-Voce	20% of the maximum	20
	Total	100%	100

Marks scored by the student for100 are scaled down to 50marks.

SEE for practical Course:

SEE marks for practical course shall be 50 marks.

Marks distribution for Experiment based Practical Course for Final SEE

SL. No.	Description	% of Marks	Marks
1	Write-up, Procedure	20%	20
2	Conduction and result	60%	60
3	Viva-Voce	20%	20
Total		**100%**	**100**

4. SEE for practical course is evaluated for 100 marks and scored marks shall be scaled down to 50 marks.
5. Change of experiment/program is allowed only once and 20% marks allotted to the procedure/writeup part to be made zero.
6. Duration of SEE shall be 3 hours.

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding Sensor Fundamentals	Students will understand the core concepts of sensor types, operating principles, and the role of sensors in various applications.
2	Analyze Sensor Characteristics	Students will be able to analyze sensor characteristics such as sensitivity, accuracy, and response time, and apply this knowledge to select appropriate sensors for specific applications.
3	Actuator Selection and Application	Students will be able to identify, evaluate, and apply different types of actuators, understanding their control mechanisms and applications in automation and control systems.
4	Smart Sensors and System Integration	Students will be able to understand and implement smart sensors, integrating them with data acquisition systems, communication interfaces, and control systems for enhanced functionality.
5	Design and Optimization of Sensor-Actuator Systems	Students will be able to design, analyze, and optimize sensor-actuator systems for specific applications, understanding the interaction between sensors, actuators, and control systems

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC607D.1	Apply the fundamental physical and technical principles of sensors and actuators.
M23BEC607D.2	Analyze the types, operation, and characteristics of different sensors, actuators, and transducers.
M23BEC607D.3	Analyze the basic laws and phenomena of different sensors and actuators on the Arduino UNO board
M23BEC607D.4	Analyze the smart sensor interfaces of different sensors and actuators on the Raspberry Pi

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC607D.1	3	3	2	3	2	-	-	-	1	1	2	2		-
M23BEC607D.2	2	2	3	3	2	-	-	-	1	1	3	2	3	
M23BEC607D.3	2	2	2	2	3	-	-	-	1	2	2	2		-
M23BEC607D.4	2	2	2	2	3	-	-	-	1	2	2	2	-	3

M23BEC607D	2.25	2.25	2.25	2.5	2.5	-	-	-	1	1.5	2.25	2	3	3

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	**CO2**	**CO3**	**CO4**	**CO5**	**Total**
Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	**CO2**	**CO3**	**CO4**	**CO5**	**Total**
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

10. Future with this Subject:

- Internet of Things (IoT): Focus: Smart sensors and connectivity. Applications: Developing smart homes, cities, and industrial systems with interconnected sensors and actuators.
- Wearable Technology: Focus: Biometric sensors and health monitoring. Applications: Enhancing wearable devices for health tracking, fitness monitoring, and personal safety.
- Autonomous Systems: Focus: Sensors for self-driving vehicles and robotics. Applications: Improving navigation, obstacle detection, and decision-making in autonomous systems.
- Environmental Monitoring: Focus: Sensors for detecting environmental changes. Applications: Air quality monitoring, climate change studies, and disaster management.
- Smart Manufacturing: Focus: Sensors in industrial automation. Applications: Enhancing precision, efficiency, and predictive maintenance in manufacturing processes.
- Advanced Actuation Technologies: Focus: Innovative actuators for various applications. Applications: Precision control in robotics, aerospace, and automation systems.

6th Semester	Non Credit Mandatory Course (NCMC) NATIONAL SERVICE SCHEME (NSS)	M23BNSK608

NATIONAL SERVICE SCHEME (NSS)			
Course Code	**M23BNSK608**		
Number of Lecture Hours/Week(L:T:P:S)	**0:0:2:0**	CIE Marks	**100**
Total Number of Lecture Hours		SEE Marks	**-**
Credits	**0**	Total Marks	**100**
Activities Report Evaluation by College NSS Officer at the end of every semester (3rd to 6th semester)			

Course objectives:

National Service Scheme (NSS) will enable students to:

1. Understand the community in general in which they work.
2. Identify the needs and problems of the community and involve them in problem–solving.
3. Develop among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems.
4. Develop competence required for group-living and sharing of responsibilities & gain skills inmobilizing community participation to acquire leadership qualities and democratic attitudes.
5. Develop capacity to meet emergencies and natural disasters & practice national integration and social harmony in general.

General Instructions-Pedagogy:

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching method may be adopted so that the activities will develop students 'theoretical and applied social and cultural skills.
2. State the need for NSS activities and its present relevance in the society and Provide real-life examples.
3. Support and guide the students for self-planned activities.
4. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress in real activities in the field.
5. Encourage the students for group work to improve their creative and analytical skills.

Sem	**Topics/Activities to be Covered**

Contents:

Organic farming, Indian Agriculture (Past, Present and Future) Connectivity for marketing.

1. Waste management– Public, Private and Govt organization,5R's.
2. Setting of the information imparting club for women leading to contribution in social and economic issues.
3. Water conservation techniques–Role of different stake holders–Implementation.
4. Preparing an actionable business proposal for enhancing the village income and approach for implementation.
5. Helping local schools to achieve good results and enhance their enrolment in

Higher/technical/vocational education.

6. Developing Sustainable Water management system for rural areas and implementation approaches.
7. Contribution to any national level initiative of Government of India. For eg. Digital India, Skill India, Swatch Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc.
8. Spreading public awareness under rural out reach programs. (minimum5programs).
9. Social connect and responsibilities.
10. Plantation and adoption of plants. Know your plants.
11. Organize National integration and social harmony events/workshops/seminars .(Minimum 02 programs).
12. Govt. school Rejuvenation and helping them to achieve good infrastructure.

NOTE:

Student/s in individual or in a group Should select any one activity in the beginning of each semester till end of that respective semester for successful completion as per the instructions of NSS officer with the consent of HOD of the department.

At the end of every semester, activity report should be submitted for evaluation.

Distribution of Activities –Semester wise from 3rd to 6thsemester

3rd Sem for 25 Marks	1. Organic farming, Indian Agriculture (Past, Present, and Future) Connectivity for marketing. 2. Waste management–Public, Private and Govt organization,5R's. 3. Setting of the information imparting club for women leading to contribution in social and economic issues.
4th Sem for 25 Marks	1. Water conservation techniques –Role of different stake holders–Implementation. 2. Preparing an actionable business proposal for enhancing the village income and approach for implementation. 3. Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/vocational education.
5th Sem for 25 Marks	1. Developing Sustainable Water management systems for rural areas and implementation approaches. 2. Contribution to any national-level initiative of the Government of India. For eg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc. 3. Spreading public awareness under rural outreach programs. (minimum 5 programs). 4. Social connect and responsibilities.
6th Sem for 25 Marks	1. Plantation and adoption of plants. Know your plants. 2. Organize National integration and social harmony events / workshops /seminars. (Minimum 02 programs). 3. Govt. school Rejuvenation and helping them to achieve good infrastructure.

Course out comes:

At the end of the course, the student will be able to:

COs	Description
M23BNSK410.1	Understand the importance of his/her responsibilities towards society.
M23BNSK410.2	Analyse the environmental and societal problems/issues and will be able to design solutions for the same.
M23BNSK410.3	Evaluate the existing system and to propose practical solutions for the same for sustainable development.
M23BNSK410.4	Implement government or self-driven projects effectively in the field.
M23BNSK410.5	Develop capacity to meet emergencies and natural disasters & practice national integration and social harmony in general.

Pedagogy–Guidelines:

It may differ depending on local resources available for the study as well as environment and climatic d,ifference, location, and time of execution.

Sl. No	Topic	Group size	Location	Activity execution	Reporting	Evaluation of the Topic
1.	Organic farming, Indian Agriculture (Past, Present, and Future) Connectivity for marketing.	May be individual or team	Farmers land/ Villages/ roadside/ community area /College campus etc	Site selection / proper consultation/ Continuous monitoring/ Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer

2.	Waste management–Public, Private and Govt organization, 5 R's.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Site selection / proper consultation/ Continuous monitoring/ Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
3.	Setting of the information imparting club for women leading to contribution in social and economic issues.	May be individual or team	Women empowerment groups/ Consulting NGOs & Govt Teams / College campus etc…	Group selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
4.	Water conservation techniques – Role of different stakeholders– Implementation.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Site selection / Proper consultation/ Continuous monitoring/ Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
5.	Preparing an actionable business proposal for enhancing the village income and approach for implementation.	May be individual or team	Villages City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Group selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
6.	Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/ vocational education.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	School selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
7.	Developing Sustainable Water management system for rural areas and implementation approaches.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Site selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer

8.	Contribution to any national-level initiative of the Government of India. For eg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Group selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
9.	Spreading public awareness under rural outreach programs. (minimum 5 programs). Social connect and responsibilities.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Group selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
10.	Plantation and adoption of plants. Know your plants.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Place selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
11.	Organize National integration and social harmony events /workshops /seminars. (Minimum 02 programs).	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Place selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
12.	Govt. school Rejuvenation and helping them to achieve good infrastructure.	May be an individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Place selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer

Plan of Action ((Execution of Activities for Each Semester)

Sl. No	Practice Session Description
1.	Lecture session by NSS Officer
2.	Students' Presentation on Topics
3.	Presentation- 1,Selectionoftopic,PHASE-1
4.	Commencement of activity and its progress-PHASE- 2

5.	Execution of Activity
6.	Execution of Activity
7.	Execution of Activity
8.	Execution of Activity
9.	Execution of Activity
10.	Case study-based Assessment, Individual performance
11.	Sector wise study and its consolidation
12.	Video-basedseminarfor10minutes by each student At the end of the semester with a Report.

- In every semester from 3rd semester to 6th semester, each student should do activities according to the scheme and syllabus.
- At the end of every semester student performance has to be evaluated by the NSS officer for the assigned activity progress and its completion.
- At last in 6th semester consolidated report of all activities from 3rd to 6th semester, compiled report should be submitted as per the instructions.

Assessment Details:

Weightage	**CIE– 100%**	
Presentation -1 Selectionoftopic,PHASE-1	**10 Marks**	• Implementation strategies of the project (NSS work). • The last Report should be signed by the NSS Officer, the HOD, and the principal. • At last Report should be evaluated by the NSS officer of the institute. • Finally, the consolidated marks sheet
Commencement of activity and its progress- PHASE-2	**10 Marks**	
Case Study-based Assessment Individual Performance with Report	**10 Marks**	
Sector-wise study & its consolidation	**10 Marks**	
Video based seminar for 10 minutes by each student At the end of semester with Report. Activities.	**10 Marks**	should be sent to the university and made available at the LIC visit.
Total marks for the course in each semester	**50 Marks**	

Marks scored for 50 by the students should be Scaled own to 25 marks In each semester for CIE entry in the VTU portal.

25 marks CIE entry will be entered in University IA marks portal at the end of each semester 3rd to 6th semester, Report and assessment copy should be made available in the department semester wise

Students should present the progress of the activities as per the schedule in the prescribed practical session in the field. There should be positive progress in the vertical order for the benefit of society ing eneral.

Suggested Learning Resources: **Books**:

1. NSS Course Manual, Published by NSS Cell, VTU Belagavi.
2. Government of Karnataka, NSS cell, activities reports and manual.
3. Government of India, NSS cell, Activities reports and manual.

6th Semester	Non Credit Mandatory Course (NCMC) YOGA	M23BYOK608
6th Semester	Non Credit Mandatory Course (NCMC) PHYSICAL EDUCATION (SPORTS AND ATHLETICS)	M23BPEK608

Scheme and Assessment for auditing the course and Grades:

PHYSICAL EDUCATION (SPORTS & ATHLETICS) (M23BPEK608)

SEMESTER–IV

Course Out comes: At the end of the course, the student will be able to

CO1: Understand the ethics and moral values in sports and athletics.

CO2: Perform in the selected sports or athletics of the student's choice.

CO3:Understand the roles and responsibilities of organization and administration of sports and games.

Module-1

Ethics and Moral Values (5hours)
Ethics in Sports
Moral Values in Sports and Games

Module-2

Specific Games (Any one to be selected by the student) (20 hours) Volleyball—Attack, Block, Service, Upper Hand Pass and Lower Hand Pass.
Throwball—Service, Receive, Spin attack, Net Drop & Jump throw.
Kabaddi—Hand Touch, Toe Touch, Thigh Hold, Ankle hold and Bonus.
Kho-Kho—Giving Kho, Single Chain, Pole dive, Pole turning, 3-6Up.
TableTennis—Service (Fore Hand & Back Hand), Receive(Fore Hand & Back Hand), Smash.
Athletics(Track/Field Events)—Any event as per availability of Ground.

Module-3

Role of Organization and administration (5 hours)

Sl. No.	Activity	Marks
1.	Participation of student in all the modules	**20**
2.	Quizzes—2, each of 15 marks	**30**
3.	Final presentation/exhibition /Participation in competitions/ practical on specific tasks assigned to the students	**50**
	Total	**100**

YOGA			
Course Code	**M23BYOK608**		
Number of Lecture Hours/Week(L:T:P:S)	**0:0:2:0**	CIE Marks	**100**
Total Number of Lecture Hours		SEE Marks	**-**
Credits	**0**	Total Marks	**100**
Evaluation Method: Objective type Theory/Practical/Viva-Voce			

Course objectives:

1. To enable the student t o have good Health.
2. To practice mental hygiene.
3. To possess emotional stability.
4. To integrate moral values.
5. To attain a higher level of consciousness.

The Health Benefits of Yoga

The benefits of various yoga techniques have been supposed to improve

- Body flexibility,
- performance,
- stress reduction,
- attainment of inner peace, and
- self-realization.

The system has been advocated as a complementary treatment to aid the healing of several ailments such as

- coronary heart disease,
- depression,
- anxiety disorders,
- asthma, and
- extensive rehabilitation for disorders including musculoskeletal problems and traumatic brain injury.

The system has also been suggested as behavioural therapy for smoking cessation and substance abuse (including alcohol abuse).

If you practice yoga, you may receive these physical, mental, and spiritual benefits:

- Physical

1. Improved body flexibility and balance
2. Improved cardio vascular endurance (stronger heart)
3. Improved digestion
4. Improved abdominal strength
5. Enhanced overall muscular strength
6. Relaxation of muscular strains
7. Weight control
8. Increased energy levels
9. Enhanced immune system

- Mental

4. Relief of stress resulting from the control of emotions
5. Prevention and relief from stress-related disorders
6. Intellectual enhancement, leading to improved decision-making skills • Spiritual

1. Life with meaning, purpose, and direction
2. Inner peace and tranquility

- Contentment

Yoga Syllabus

Semester VI

- **Ashtanga Yoga**
  1. Dharana
  2. Dhyana(Meditation)
  3. Samadhi
- Asana by name, technique, precautionary measures and benefits of each asana
- Different types of Asanas

a. Sitting1.Bakasana2.Hanumanasana 3.EkapadaRajakapotasana4. Yogamudrain Vajrasana b. Standing1. Vatayanasana2. Garudasana

c. Balancing1.Veerabhadrasana2. Sheershasana

d. Supine line1. Sarvangasana2.SetubandhaSarvangasana3.Shavasanaa(Relaxationpoisture).

- Revision of Kapalabhati practice80strokes/min-3rounds
- Different types. Meaning by name, technique, precautionary measures and benefits of each Pranayama1. Bhastrika2. Bhramari
- Meaning, Need, importance of Shatkriya.

Different types. Meaning by name, technique, precautionary measures and benefits of each Kriya1.Jalaneti & sutraneti2. Nouli(onlyfor men)3. Sheetkarma Kapalabhati **Course outcomes:**
At the end of the course, the student will be able to:

- Understand the meaning, aim and objectives of Yoga.
- Perform Suryanamaskar and able to Teach its benefits.
- Understand and teach different Asanas by name, its importance, methods and benefits.
- Instruct Kapalabhati and its need and importance.
- Teach different types of Pranayama by its name, precautions, procedure and uses
- Coach different types of Kriyas, method to follow and usefulness.

Assessment Details(both CIE and SEE)

- Students will be assessed with internal test by a. Multiple choice questions b. Descriptive type questions (Two internal assessment tests with 25 marks/test).
- Final test shall be conducted for whole syllabus for 50marks.

Continuous Internal Evaluation shall be for 100 marks(including IA test)

Suggested Learning Resources: Books:

1. Yogapravesha in Kannada by Ajitkumar
2. Light onYoga by BKS Iyengar
3. Teaching Methods for Yogic practices by Dr. ML Gharote & Dr.SK Ganguly
4. Yoga Instructor Course hand book published by SVYASA University, Bengaluru
5. Yoga for Children–step by step –by Yamini Muthanna

Web links and Video Lectures (e-Resources):Refer links
https://youtu.be/KB-TYlgd1wE https://youtu.be/aa-TG0Wg1Ls