VIT Vidyalankar Institute of Technology
Accredited A+ by NAAC

Vidyalankar Institute of Technology

An Autonomous Institute affiliated to University of Mumbai

Bachelor of Technology

In

Electronics and Computer Science

Third Year Scheme & Syllabus

(R 2023)

(As per NEP 2020, with effect from the Academic Year 2025-26)

Preamble

The National Education Policy (NEP) framework aims to break the mold from teacher centric to student centric educational practices. It empowers the students with flexibility in terms of choosing courses across different faculties and modes of learning.

This multidisciplinary approach will encourage learners to follow their passion and inherent interests. The learner is free to learn at a pace that he is comfortable with, and this enables lifelong learning. It also enhances the scope for holistic personality development.

This premise is truly reflected in preamble of the NEP document, "The future of nation is decided in the classrooms of the schools and colleges today".

Details of implementation:

NEP curriculum framework enables us to accelerate change, redesign systems with equity in mind, respond to feedback, encourage collaboration, catch and pollinate ideas and create a culture of research and development. It will allow us to offer the required academic flexibility which will focus on improving competency level of students with diverse strengths.

The curriculum planned by VIT has vertical **Program Courses** consisting of Programme core courses (PCC) of branch of engineering positioned and sequenced to achieve sequential and integral learning of the entire breadth of the specific branch. This vertical also includes Programme elective courses (PEC) which offer flexibility and diversity to learners to choose specialization from a basket of recent developments in their field of technology. The selection of unique professional elective courses based on industrial requirements and organizing them into tracks is a special feature of this curricula ensuring employability.

The vertical **Multidisciplinary Courses** consists of Open Elective (OE) courses and multidisciplinary minor (MD M) courses. Special vocational and skill development courses are included as a part of **Skill courses** vertical that make student capable to work in industrial environment.

The student is expected to demonstrate their ability through courses in **Experiential Learning Courses** vertical like internships/On Job Training, Community Engagement Project, Real Industry Project/ research problem. Our curriculum also introduces Social Service Internship and Internship with institutes abroad along with courses like Design Thinking. This will lead to the creation of products and/ or patents through this program.

For holistic development of students, apart from technical courses, Ability Enhancement Courses, Entrepreneurship/Economics/Management Courses, Indian Knowledge System and Value Education courses from vertical **Humanities and Social Science and Management** develop the required soft-skills and attitude amongst learners.

In **Liberal Learning** vertical courses like Various Dance Forms, Global citizenship Education, Facets of Astronomy etc. aim to create balance in brain hemispheres and hence improve learners' clarity in thoughts and responses.

In addition to core courses, professional and open electives; our framework offers honor degree in each programme of engineering. It includes specialized courses along with field/ domain study that make students capable of working on industry relevant problems.

Chairperson, Board of Studies
Department of Electronics and Computer Science
Vidyalankar Institute of Technology

Chairperson, Academic Council
Vidyalankar Institute of Technology

Third Year B. Tech. Electronics and Computer Science **Semester: V**
Course Structure and Assessment Guidelines

Course			Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
NEP-Vertical	Code	Name			ISA	MSE	ESE	
MC-MDM	MDMXX	Multidisciplinary Minor Course-1	Theory	4	45	30	50	125
PC-PCC	PCEC08T	Basic VLSI Design	Theory	2	15	20	40	075
	PCEC08P	Basic VLSI Design Lab	Practical	1	25	-	25	050
PC-PCC	PCEC09T	Microcontroller and Applications	Theory	2	15	20	40	075
	PCEC09P	Microcontroller and Applications Lab	Practical	1	25	-	25	050
PC-PCC	PCEC10T	Operating System	Theory	2	15	20	40	075
	PCEC10P	Operating System Lab	Practical	1	25	-	25	050
PC-PCC	PCEC11T	Analysis of Algorithms	Theory	2	15	20	40	075
	PCEC11P	Analysis of Algorithms Lab	Practical	1	25	-	25	050
PC-PEC	PEECxxT	Professional Elective-1	Theory	2	15	20	40	075
	PEECxxP	Professional Elective-1 Lab	Practical	1	25	-	25	050
ELC	PRJEC01	Mini Project 1	Practical	2	25	-	50	075
Total Credits				**21**				
Course credits completed during the previous inter semester break will appear in this semester's marksheet								
MC-OE	OEC01[$]	Collaborative Inter-Institute Studies	As per course	4	125	-	-	125

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESA= End Semester Examination

[$] **For Collaborative Inter-Institute Studies:** Collaboration with other reputed institutes equivalent to 4 credits is recommended to be done by learner during second year inter semester break (i.e. summer break between semester 4 and semester 5).
NOTE: As per Institute guidelines, the result of courses completed in inter-semester break will appear in the marksheet of the next semester.

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based

on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Guidelines for Programme Elective Courses and Specialization Certificate – Refer Appendix-A

Learners are required to go through Appendix-A carefully before selecting the Programme Elective courses. Detailed guidelines regarding Programme Elective courses, specialization tracks and courses relevant to each track are given in Appendix-A.

Programme Elective -1 Courses (PEECXX)

Specialization Track Name#	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
Artificial Intelligence and Machine Learning (AIML)	PEEC01T	Artificial Intelligence	Theory	2	15	20	40	075
	PEEC01P	Artificial Intelligence lab	Practical	1	25	-	25	050
Data Analytics (DA)	PEEC02T	Advanced Database Management System	Theory	2	15	20	40	075
	PEEC02P	Advanced Database Management System Lab	Practical	1	25	-	25	050
Internet of Things (IoT)	PEEC03T	Modern Sensors for IOT	Theory	2	15	20	40	075
	PEEC03P	Modern Sensors for IOT Lab	Practical	1	25	-	25	050
VLSI Design	PEEC04T	Digital System Design	Theory	2	15	20	40	075
	PEEC04P	Digital System Design Lab	Practical	1	25	-	25	050

#For details of Specialization Certificate, refer Appendix-A

Guidelines for Multidisciplinary Elective Courses and Minor Degree – Refer Appendix-B (Programme Structure)

Learners are required to go through the Appendix-B carefully before selecting the Multidisciplinary Elective courses. Detailed guidelines regarding Multidisciplinary Elective courses, Minor Degree Titles and courses relevant to each MDM Title are given in Appendix-B (Programme Structure).

Multidisciplinary Minor Courses (MDM)

Specialization Track Name#	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40 % of total marks)
	Code	Name			ISA	MSE	ESE	
Bioinformatics	MDMBI01	Introduction to Bioinformatics	Theory	4	45	30	50	125
Innovation, Entrepreneurship and Venture Development	MDMIE01	Foundations of Innovation and Entrepreneurship	Theory	4	45	30	50	125
Business Development, Marketing and Finance	MDMBD01	Introduction to Business Development and Marketing Principles	Theory	4	45	30	50	125
Robotics	MDMRB01	Fundamentals of Robotics and Control	Theory	4	45	30	50	125

Guidelines for Awrad of Honours/Minor Degree

Before the end of Semester 5, learners are required to go through the Honours/Minor Degree Programme document carefully to opt for Honours/Minor Degree Programme. Learners willing to opt for the Honours/ Minor Degree Programme are required to satisfy the eligibility criteria stated in the document.

Third Year B. Tech. Electronics and Computer Science **Semester: VI**

Course Structure and Assessment Guidelines

Course			Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
NEP-Vertical	Code	Name			ISA	MSE	ESE	
PC-PCC	PCEC12T	Theory of Computer Science	Theory + Tutorial	3	40	20	40	100
PC-PCC	PCEC13T	Computer Networks	Theory	2	15	20	40	075
	PCEC13P	Computer Networks Lab	Practical	1	25	-	25	050
PC-PCC	PCEC14T	Analog & Digital Communications	Theory	2	15	20	40	075
	PCEC14P	Analog & Digital Communications Lab	Practical	1	25	-	25	050
PC-PEC	PEECXXT	Professional Elective-2	Theory	2	15	20	40	075
	PEECXXP	Professional Elective-2 Lab	Practical	1	25	-	25	050
PC-PEC	PEECXXT	Professional Elective-3	Theory	2	15	20	40	075
	PEECXXP	Professional Elective-3 Lab	Practical	1	25	-	25	050
MC-MDM	MDMXX	Multidisciplinary Minor Course-2	Theory	4	45	30	50	125
MC-MDM	MDM01	Skill and Competency Development 1	Practical	1	50	-	-	050
ELC	PRJ02	Project-1 (Synopsis)	Theory+ Practical	2	50	-	25	075
Total Credits				**22**				

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESA= End Semester Examination

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

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Programme Elective - 2 Courses (PEECXX)

Specialization Track Name[#]	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
Artificial Intelligence and Machine Learning (AIML)	PEEC05T	Soft Computing	Theory	2	15	20	40	075
	PEEC05P	Soft Computing Lab	Practical	1	25	-	25	050
Data Analytics (DA)	PEEC06T	Data Warehousing and Mining	Theory	2	15	20	40	075
	PEEC06P	Data Warehousing and Mining Lab	Practical	1	25	-	25	050
Internet of Things (IoT)	PEEC07T	Principles of IOT	Theory	2	15	20	40	075
	PEEC07P	Principles of IOT Lab	Practical	1	25	-	25	050
Very Large-Scale Integration (VLSI)	PEEC08T	Advanced VLSI Design and Technology	Theory	2	15	20	40	075
	PEEC08P	Advanced VLSI Design and Technology Lab	Practical	1	25	-	25	050

[#]For details of Specialization Certificate, refer Appendix-A

Programme Elective - 3 Courses (PEECXX)

Specialization Track Name[#]	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
Artificial Intelligence and Machine Learning (AIML)	PEEC09T	Machine Learning	Theory	2	15	20	40	075
	PEEC09P	Machine Learning Lab	Practical	1	25	-	25	050
Data Analytics (DA)	PEEC10T	Probabilistic Graphical Models	Theory	2	15	20	40	075
	PEEC10P	Probabilistic Graphical Models Lab	Practical	1	25	-	25	050
Internet of Things (IoT)	PEEC11T	Embedded System Design with tiny OS	Theory	2	15	20	40	075
	PEEC11P	Embedded System Design with tiny OS Lab	Practical	1	25	-	25	050
VLSI Design	PEEC12T	Analog IC Design	Theory	2	15	20	40	075
	PEEC12P	Analog IC Design Lab	Practical	1	25	-	25	050

[#]For details of Specialization Certificate, refer Appendix-A

Multidisciplinary Minor Courses (MDM)

Specialization Track Name#	Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40 % of total marks)
	Code	Name			ISA	MSE	ESE	
For all Tracks	MDM01	Skill and Competency Development 1	Practical	1	50	-	-	050
Bioinformatics	MDMBI02	Algorithms and Data Structures in Bioinformatics	Theory	4	45	30	50	125
Innovation, Entrepreneurship and Venture Development	MDMIE02	Startup Planning and Development	Theory	4	45	30	50	125
Business Development, Marketing and Finance	MDMBD02	Financial Basics for Engineers and Technopreneurs	Theory	4	45	30	50	125
Robotics	MDMRB02	Machine Vision and Robotic Perception	Theory	4	45	30	50	125

Third Year B. Tech. Electronics and Computer Science - Summer Break

Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
Code	Name			ISA	MSE	ESE	
OJT01*	Industry Internship 1	Practical	5	75	-	75	150

*150+ hours of industry internship to be done during inter semester break between semester 6 and semester 7.

NOTE: As per Institute guidelines, the results of courses completed in inter-semester break will appear in the marksheet of the next semester.

Detailed Syllabus of Third Year Semester - V

Course Name: Basic VLSI Design

Course Code: PCEC08T

NEP Vertical Basket: PC_PCC

Preamble:

Digital VLSI Design is the art and science of integrating millions to billions of transistors on a single chip to create powerful, compact, and energy-efficient digital circuits. At the heart of this discipline is the mastery of digital logic, enabling the creation of microprocessors, memory units, and diverse integrated circuits that underpin modern computing devices. The landscape of Digital VLSI Design is marked by a delicate balance between intricate circuitry and the imperative to minimize physical footprint. It plays a pivotal role not only in traditional computing but also in propelling innovations in emerging fields like artificial intelligence, machine learning, and the Internet of Things. This course provides an overview of the techniques and challenges such as shrinking transistor sizes, noise resilience, and power optimization.

Pre-requisite:

- Digital Electronics
- Electronic Devices and Circuits
- Computer Organization and Architecture

Course Objectives:

- To understand VLSI Design flow and technology trends.
- To realize MOS based circuits using different design styles.
- To study semiconductor memories using MOS logic.
- To study adder, multiplier, and shifter circuits for realizing data path design.

Course Outcomes:

After successful completion of the course students will be able to:
CO1: Demonstrate a clear understanding of VLSI Design flow, technology trends, scaling and MOSFET models.
CO2: Design and analyze MOS based inverters.
CO3: Apply design styles for realization of Combinational and Sequential Circuits.
CO4: Understand various semiconductor memories using MOS logic.
CO5: Design adder, multiplier and shifter circuits using MOS logic.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Unit No.	Contents	Hrs.
1		**MOS Physics and MOSFET Scaling**	05
	1.1	MOS structure and MOS Capacitance, Region of Operation of MOS (Accumulation, Depletion, and Inversion), Threshold Voltage, Effect of Body Bias	
	1.2	Region of operation of MOSFETS, Drain Current Equation of MOSFET, Parasitic capacitances in MOSFET	
	1.3	MOSFET Scaling: Constant Voltage and Constant Field, Effect of Scaling on Device parameters. Short Channel Effect: Channel Length Modulation, sub-threshold conduction, hot electron effect and velocity saturation.	
2		**MOSFET Inverters**	07
	2.1	Introduction to MOS inverters: Active and passive load nMOS inverters, CMOS inverter and their comparison.	
	2.2	Static & Dynamic Analysis of Ressitive load and CMOS Inverter: Calculation of critical voltages, noise margins, rise time, fall time, propagation delay and power dissipation. Design of CMOS inverter.	
3		**Combinational and Sequential Circuit Realization**	07
	3.1	Static CMOS, Analysis and design of 2-I/P NAND, 2-I/P NOR and complex Boolean function realization using equivalent CMOS inverter for simultaneous switching	
	3.2	Basic gates and MUX realization using pass transistor and transmission gate logic Pseudo NMOS design styles, C^2MOS, Dynamic, Domino, NORA and Zipper CMOS design styles.	
	3.3	SR Latch, JK FF, D FF, 1 Bit Shift Register realization using CMOS logic	
4		**Semiconductor Memories**	06
	4.1	SRAM: 6T SRAM operation, design strategy, read/write circuits, sense amplifier	
	4.2	DRAM: 1T & 3T DRAM, operation modes, leakage currents, refresh operation, physical design.	
	4.3	ROM Array: NAND and NOR based ROM array	
	4.4	Non-volatile read/write memories: Programming techniques for flash memory, Introduction to advances in non-volatile memories: MRAM, ReRAM	
5		**Data Path Design**	05
	5.1	Adder: Ripple Carry Adder, Carry Look Ahead (CLA) adder, Carry Generation circuit using MODL, Manchester carry chain. High-speed adders: carry skip, carry select, and carry save	
	5.2	Multipliers and shifter: Array multiplier and barrel shifter	
Total			**30**

Textbooks:

Sr. No	Textbook Titles	Author/s	Publisher	Edition	Module Nos.
1	CMOS Digital Integrated Circuits Analysis and Design	Sung-Mo Kang and Yusuf Leblebici,	Tata McGraw Hill	Revised 4th Edition	1,2,3,4,5
2	Introduction to VLSI Circuits and Systems	John P. Uyemura	Wiley India Pvt. Ltd.	Revised 4th Edition	3,4,5

Reference Books:

Sr. No	Text Book Titles	Author/s	Publisher	Edition	Module Nos.
1	Digital Integrated Circuits: A Design Perspective	Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic	Pearson Education	2nd	2,3,4,5
2	Basic VLSI Design	Douglas A Pucknell, Kamran Eshraghian,	Prentice Hall of India Private Ltd.	3rd	1,2,3,4,5
3	Logical Effort: Designing Fast CMOS Circuits	Ivan Sutherland and Bob Sproull,	The Morgan Kaufmann Series in Computer Architecture and Design	4th	2
4	Basics of CMOS Cell Design	Etienne Sicard and Sonia Delmas Bendhia	Tata McGraw Hill	4th	1,2,3,4,5
5	CMOS VLSI Design: A Circuits and Systems Perspective	Neil H. E. Weste, David Harris and Ayan Banerjee,	Pearson Education	5th	1,2,3,4,5
6	Analysis and Design of Digital Integrated Circuits	David Hodges, Horace Jackson, Resve Saleh.	McGraw-Hill, Inc.	3rd	1,2,3,4,5
7	Advanced Semiconductor Memories: Architectures, Designs, and Applications	Ashok K. Sharma,	Wiley Publication	4th	4
8	Magnetic Memory Technology: Spin-Transfer-Torque MRAM and Beyond	Denny D.Tang, Chi-Feng Pai,	Wiley online Library	2nd	4
9	Resistive Switching: From Fundamentals of Nanoionic Redox Processes to Memristive Device Applications.	Daniele Ielmini, Rainer Waser,	Wiley online Library	3rd	4

Course Name: Basic VLSI Design Lab

Course Code: PCEC08P

NEP Vertical Basket: PC_PCC

Preamble:
Digital VLSI Design is the art and science of integrating millions to billions of transistors on a single chip to create powerful, compact, and energy-efficient digital circuits. At the heart of this discipline is the mastery of digital logic, enabling the creation of microprocessors, memory units, and diverse integrated circuits that underpin modern computing devices. The landscape of Digital VLSI Design is marked by a delicate balance between intricate circuitry and the imperative to minimize physical footprint. It plays a pivotal role not only in traditional computing but also in propelling innovations in emerging fields like artificial intelligence, machine learning, and the Internet of Things. This course provides an overview of the techniques and challenges such as shrinking transistor sizes, noise resilience, and power optimization.

Pre-requisite:

- Digital Electronics
- Electronic Devices and Circuits
- Computer Organization and Architecture

Course Objectives:
- To understand VLSI Design flow and technology trends.
- To realize MOS based circuits using different design styles.
- To study semiconductor memories using MOS logic.
- To study adder, multiplier, and shifter circuits for realizing data path design.

Course Outcomes:
After successful completion of the course students will be able to:
CO1: Demonstrate a clear understanding of VLSI Design flow, technology trends, scaling and MOSFET models.
CO2: Design and analyze MOS based inverters.
CO3: Apply design styles for realization of Combinational and Sequential Circuits.
CO4: Understand various semiconductor memories using MOS logic.
CO5: Design adder, multiplier and shifter circuits using MOS logic.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Guidelines:

Head of Learning	**ISA**	**MSE**	**ESE**	**Total**
Practical	25	-	25	50

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested list of Practicals:

Practical No.	Module No.	Suggested list of Experiments	Topics to be highlighted	CO Map
1	1	To observe the effect of scaling on the characteristics of various MOSFET's	See the effect of Constant voltage and constant field Scaling	CO1
2	2	Design and Simulation to Symmetric and Non-Symmetric CMOS Inverter	How to control the inverter threshold	CO2
3	2	Comparison of different inverters based on Critical Parameter, timing parameters and Noise margins	Comparison of various types of inverters	CO2
4	2	Design and Implementation of Equivalent inverter for any CMOS logic function.	Concept of Equivalent inverter and relevance to timing analysis	CO2
5	3	Comparison of Pseudo NMOS and CMOS Logic functions.	Pseudo NMOS Logics	CO3
6	3	Comparison of dynamic and CMOS logic functions	Dynamic Logics	CO3
7	3	Comparison of domino and CMOS logic functions	Implementation of Uncomplemented functions	CO3
8	3	Implementation of functions using NORA and Zipper CMOS	Zipper CMOS	CO3
9	3	Implementation of Logic functions using NMOS, PMOS and Pass transistor logic	Change in voltage levels while passing a logic value	CO3
10	3	Implementation of 8:1 Mux and 1:8 Demux using NMOS, PMOS and transmission gates.	MUX and DEMUX operation using Pass transistor logic	CO3
11	4	Implementation of SRAM Cell	Read, Write and Hold operations in a DRAM	CO5
12	4	Design of NOR based and NAND Based ROM	Concept of Non-Volatile Memory	CO4
13	5	Implementation of 4-bit adder Ripple Carry Adder	Delay introduced while adding many bits	CO5
14	5	Implementation of 4- bit Carry look ahead adder with carry generation circuit using MODL	Reduction of delay during adding two binary numbers	CO5
15	5	Design of 4 x 4 Barel shifter using NMOS transistors	Data Steering, rotate left and rotate right operations	CO5
16	1,2,3,4,5	Simulation of Complete Digital Design Flow in Cadence	Digital Design Flow using Cadence	CO1,2,3,4,5
17	1,2,3,4,5	Simulation of Complete Analog Design Flow in Cadence	Analog Design Flow using Cadence.	CO1,2,3,4,5

Course Name: Microcontroller and Applications

Course Code: PCEC09T

NEP Vertical Basket: PC_PCC

Preamble:

A professional in any field of computing should be able to appreciate the difference between Microprocessor and Microcontroller and should be able to understand the fundamental units of a Microcontroller. A knowledge of programming in assembly language as well as embedded C for microcontroller-based systems is a must. The course provides the in-depth knowledge of Microcontroller based systems and programming with it.

Pre-requisite:

Digital Electronics
Computer Organization and Architecture
Fundamental concepts of processing

Course Objectives:

- To introduce the learner to the basic difference between Microprocessor and Microcontroller and design Microcontroller based systems
- To introduce the learner to the concept of assembly language programing
- To introduce the learner to the concept of embedded C programing

Course Outcomes:

After successful completion of the course students will be able to:
CO1: Understand fundamental concepts of microcontrollers
CO2: Explain different building blocks of microcontrollers
CO3: Apply the knowledge of instruction set of microcontroller to develop assembly language and embedded C programs
CO4: Analyze the performance of a microcontroller by interfacing different peripherals and writing simple applications

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	8051 Microcontroller Architecture	Introduction to the concepts of Microprocessors and Microcontrollers Overview of various available Microcontrollers Applications of Microcontrollers 8051 Architecture	4
2	8051 Internal Hardware	Memory organization Timers/Counters and programming Serial port and programming Interrupts and Interrupt control Power Saving modes	6
3	8051 Assembly language programming	Addressing modes of 8051 Instruction Set: Data transfer instructions, Arithmetic instructions, Logical instructions, Bit Processing, Branching instructions, Assembler directives	6
4	8051 programming in Embedded C	Embedded C-programming concepts: Data types, Modifiers, Qualifiers, Functions, Macros, Interrupt service routines Embedded C programming for 8051 (Timers/Counters, Serial port and Interrupts)	6
5	8051 Interfacing –Part 1	Display interfacing: 7-segment LED display, 16x2 generic alphanumeric LCD display Keyboard interfacing: 4x4 matrix keyboard	4
6	8051 Interfacing –Part 2	Analog devices interfacing: 8-bit ADC, 8-bit DAC, temperature sensor (LM35) Motor interfacing: Relay, DC motor (speed control using PWM), Stepper motor and Servo motor	4
Total			**30**

Text Books:

1. M. A. Mazidi, J., C. Mazidi, Rolin, D. McKinlay, "The 8051 Microcontroller and Embedded Systems Using Assembly and C", Pearson Education, 2nd edition.
2. Kenneth J. Ayala, "The 8051 Microcontroller", Cengage Learning India Pvt. Ltd, 3rd edition.

Reference Books:

1. Raj Kamal, "Microcontrollers: Architecture, Programming, Interfacing and System Design", Pearson Education, 2009, 2nd edition.
2. Manish K Patel, "The 8051 Microcontroller Based Embedded Systems", McGraw Hill, 2014, 3rd edition.
3. Ajay V Deshmukh," Microcontroller Theory and Applications", Tata McGraw Hill, 2017, 3rd edition.

Course Name: Microcontroller and Applications Lab

Course Code: PCEC09P

NEP Vertical Basket: PC_PCC

Preamble:

A professional in any field of computing should be able to appreciate the difference between Microprocessor and Microcontroller and should be able to understand the fundamental units of a Microcontroller. A knowledge of programming in assembly language as well as embedded C for microcontroller-based systems is a must. The course provides the in-depth knowledge of Microcontroller based systems and programming with it.

Pre-requisite:

Computer Organization and Architecture
Fundamentals of C programming

Course Objectives:

- To introduce learners with basic principles about microcontroller architecture, machine language, and low-level programming.
- To introduce learners with enough assembly language and embedded C to enhance their knowledge of today's most widely used microcomputer family.
- To Improving learners systems programming skills through programming exercises carried out by students.

Course Outcomes:

After successful completion of the course students will be able to:
CO1: Understand instruction set/format of a microcontroller.
CO2: Understand concept of assembly language and embedded C programming.
CO3: Develop assembly language and embedded C program for simple applications.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Experiments

Sr No.	Suggested Experiments
1.	Develop assembly language code to add, subtract, multiply, divide, two, 8-bit numbers which will occupy minimum program memory space.
2.	Develop assembly language code to convert the input from keyboard to the format which can be used for processing internally.
3.	Given a bucket of ten, 8-bit numbers, develop assembly language code to find out smallest and largest element out of the bucket.
4.	Given an 8-bit numbers, develop assembly language code to check whether it is odd or even and to find out whether it has odd or even parity.
5.	It is required to glow the LED connected on P1.0 for some time and switch it OFF for the same time and repeat this for infinite time, develop the assembly code for the same.
6.	Develop assembly and C language code to display rolling pattern from left to right and right to left on the LEDs connected to PORT 1.
7.	Interface a 4 x 4 matrix type of keyboard with 8051. Develop assembly and C language code to detect the key closure.
8.	Interface a 4-phase stepper motor with 8051. Develop assembly and C language code to rotate the stepper motor clockwise for some time and anti-clockwise for the same time continuously.
9.	Interface a common cathode type of 7-segment display with 8051. Develop assembly and C language code to demonstrate Up/Down counting continuously.
10.	Interface 8-bit DAC, 0808 with 8051. Develop assembly and C language code to generate continuous rectangular wave with 1 kHz frequency and 40% duty cycle.

Textbooks:

1. M. A. Mazidi, J., C. Mazidi, Rolin, D. McKinlay, "The 8051 Microcontroller and Embedded Systems Using Assembly and C", Pearson Education, 2nd edition.
2. Kenneth J. Ayala, "The 8051 Microcontroller", Cengage Learning India Pvt. Ltd, 3rd edition.

Reference Books:

1. Raj Kamal, "Microcontrollers: Architecture, Programming, Interfacing and System Design", Pearson Education, 2009, 2nd edition.
2. Manish K Patel, "The 8051 Microcontroller Based Embedded Systems", McGraw Hill, 2014, 3rd edition.
3. Ajay V Deshmukh," Microcontroller Theory and Applications", Tata McGraw Hill, 2017, 3rd edition.

Course Name: Operating System

Course Code: PCEC10T

NEP Vertical Basket: PC_PCC

Preamble:

The goal of the course is to introduce the students to modern operating systems design. This course covers the design and implementation of operating systems with a focus on modern, concurrent kernels.

Pre-requisites:

Data Structure

Course Objectives:

- To enable learner to understand how operating system manages allocation and deallocation ofdifferent resources needed by user/ application.
- To enable learner to understand how operating system controls access to various resources andprovides security.
- To enable learner to evaluate performance of different approaches used by operating systems, foreffective resource utilization.

Course Outcomes:

Learner will be able to:
CO1: Understand the benefits of software modularity and how it applies to OS design.CO2: Compare various OS scheduling policies based on performance parameters.
CO3: Analyze methods to achieve synchronization and handle deadlocks.
CO4: Evaluate performance of Memory allocation and replacement policies.
CO5: Compare various files and I/O management techniques.
CO6: Understand how principles of general OS are applied in Linux OS.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table.

Notwithstanding the above, each course faculty shall have the choice to decide her/his assessmentmethodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of thesemester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Operating System	Operating System definitions, Functions of Operating System, Operating System Structures, User mode and kernel mode of a process, Types of Operating System, System Calls, Booting	4
2	Process Management and Synchronization	Process Management: Definition of Process, Process Control Block, Process Scheduling: Types and scheduling algorithms (FCFS, SJF, SRTN, Priority, RR), Threads: Definition and Concept of Multithreading. Process Synchronization: Principles of Concurrency, Inter-process communication, Critical-Section Problem, Peterson's Solution, Synchronization Hardware, Semaphores, Producer and Consumer problem,	6
3	Deadlock	Principles of Deadlock: Conditions and Resource, Allocation Graphs, Deadlock Prevention, Deadlock Avoidance: Banker's Algorithm, Deadlock Detection and Recovery, Dining Philosophers Problem.	5
4	Memory Management	Memory Management Requirements, MemoryPartitioning: Fixed, Partitioning, Dynamic Partitioning,Memory Allocation Strategies: Best-Fit, First Fit, Worst Fit,Paging and Segmentation, TLB, Page table design Virtual Memory: Demand Paging, Page Replacement Strategies: FIFO, Optimal, LRU	6
5	File Systems and I/O Management	Files and File Systems, Directory Systems, File allocation methods: Contiguous allocation, Linked allocation, Indexed allocation, Kernel I/O subsystem, Communication and Data Transfer with I/O Devices, Disk Organization, I/O Management and Disk Scheduling: FCFS, SSTF, SCAN, CSCAN, LOOK, C-LOOK, RAID Structure	5
6	The Linux System	Design Principles, Kernel Modules, Process Management, Scheduling, Memory Management, File Systems	3
Total			**30**

Textbooks:

1. William Stallings, Operating System: Internals and Design Principles, Prentice Hall, 8thEdition, 2014,ISBN-10: 0133805913 • ISBN-13: 9780133805918
2. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, John Wiley&Sons, Inc., 9thEdition, 2016, ISBN 978-81-265-5427-0
3. Andrew Tannenbaum, Operating System Design and Implementation, Pearson, 3rdEdition.

Reference Books:

1. Sumitabha Das, "UNIX: Concepts and Applications", McGraw Hill, 4thEdition
2. Achyut Godbole and Atul Kahate, Operating Systems, McGraw Hill Education, 3rdEdition

Course Name: Operating System Lab

Course Code: PCEC10P

NEP Vertical Basket: PC_PCC

Preamble:

The course introduces learners to Linux shell commands and simulate various algorithms used by generalOS for managing resources. This courses project will explore the key operating system facilities in the relative isolation of an OS development framework with the goal of maximizing experiential learning.

Pre-requisites:

Data Structure Lab

Course Objectives:

- To enable learner to visualize the working of operating system by simulating techniques used by itto manage resources.
- To enable learner to apply techniques of process synchronization in multithreaded programs and hence develop concurrent applications.

Course Outcomes:

Learner will be able to:
CO1: Understand various shell commands of Linux OS.
CO2: Compare performance of different process scheduling policies.
CO3: Perform process/ thread synchronization for consistency and concurrency.
CO4: Simulate OS techniques for memory and virtual memory management.
CO5: Develop project to explore key OS facilities.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessmentmethodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Practicals:

Sr No.	Suggested Topic(s)
1.	Linux commands
2.	Non-Preemptive process Scheduling
3.	Preemptive process Scheduling
4.	Process synchronization using mutex locks.
5.	Deadlock Handling
6.	Dynamic memory allocation techniques
7.	Adddress translation in virtual memory
8.	Page replacement policies
9.	Disk scheduling techniques

Textbooks:

2. William Stallings, Operating System: Internals and Design Principles, Prentice Hall, 8thEdition, 2014,ISBN-10: 0133805913 • ISBN-13: 9780133805918
3. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, John Wiley &Sons, Inc., 9thEdition, 2016, ISBN 978-81-265-5427-0
4. Andrew Tannenbaum, Operating System Design and Implementation, Pearson, 3rdEdition.

Reference Books:

2. Sumitabha Das, "UNIX: Concepts and Applications", McGraw Hill, 4thEdition
2. Achyut Godbole and Atul Kahate, Operating Systems, McGraw Hill Education, 3rdEdition

Course Name: Analysis of Algorithms

Course Code: PCEC11T

NEP Vertical Basket: PC_PCC

Preamble:

The course covers the fundamental principles and techniques used in designing and analyzing algorithms. Students will learn how to analyze the performance of algorithms, measure their efficiency, and compare different algorithms based on their time and space complexity. The course is designed for students with a solid understanding of programming and data structures. By the end of the course, students will have a deep understanding of the principles of algorithm design and analysis and will be equipped with the tools and techniques necessary to develop efficient algorithms for a wide range of computational problems.

Pre-requisites:

Engineering Mathematics-III – Sem 3
Data Structures – Sem 3

Course Objectives:

- To provide a deep understanding of algorithmic design and analysis techniques that enable the development of efficient and effective algorithms for solving computational problems.
- To develop a strong foundation in the theory of algorithms, including concepts such as time and space complexity, algorithmic paradigms, data structures, graph algorithms, sorting and searching, and dynamic programming.
- To equip students with the tools and techniques necessary to compare and evaluate the performance of different algorithms and choose the best algorithm for a given problem.
- To provide students with the knowledge and skills required for a successful career in software development, data analysis, and other fields that require strong analytical and problem-solving abilities

Course Outcomes:

Learner will be able to:
CO1: Analyze the time and space complexity of algorithms.
CO2: Apply and Analyze Divide and Conquer strategy to solve given problems.
CO3: Apply and Analyze Greedy strategy to solve given problems.
CO3: Apply and Analyze Dynamic Programming strategy to solve given problems.
CO4: Apply and Analyze Backtracking, Branch and Bound strategy to find solution for the given problems.
CO5: Classify a problem as computationally tractable or intractable and discuss strategies to address intractability.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Introduction to Algorithm Analysis	Performance analysis: Space, and Time complexity, Growth of function. Asymptotic Notations: Big-Oh, Omega Theta notation. Analysis of selection sort, insertion sort and Naïve String- Matching Algorithm. Recurrences: The substitution method, Recursion tree method, Master method.	8
2	Divide and Conquer Approach	General method, Analysis of Merge sort and Quick sort, Finding minimum and maximum algorithms and their Analysis, Analysis of Binary search.	4
3	Greedy Method Approach	General Method, Analysis of Minimum cost spanning trees: Kruskal and Prim's algorithm, Single source shortest path: Analysis of Dijkstra's Algorithm, Fractional Knapsack Problem and Job Sequencing with Deadlines	6
4	Dynamic Programming Approach	General Method, Finding nth term in Fibonacci series, Single Source Shortest Path: Bellman Ford Algorithm All Pair Shortest Path: Floyd Warshall's Algorithm, Longest Common Subsequence,0/1 Knapsack Problem, Matrix Chain Multiplication and Sum of Subset Problem.	7
5	Backtracking and Branch and Bound	General Method, Backtracking: N-queen problem, Graph Coloring. Branch and Bound: 15 Puzzle problem, Travelling Salesperson Problem	3
6	Introduction to Complexity Theory	The class P and NP. Polynomial reduction. NP-Complete Problems. NP-Hard Problems	2
Total			**30**

Text Books:

1. T. H. Cormen, C.E. Leiserson, R. L. Rivest, and C. Stein, "Introduction to algorithms", 2nd Edition, PHI Publication 2005.
2. Jon Kleinberg, Eva Tardos "Algorithm Design", Pearson Education.
3. Ellis Horowitz, Sartaj Sahni, S. Rajsekaran. "Fundamentals of computer algorithms" University Press.

Reference Books:

1. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGraw-Hill Edition.
2. S. K. Basu, "Design Methods and Analysis of Algorithm", PHI.

Course Name: Analysis of Algorithms Lab

Course Code: PCEC11P

NEP Vertical Basket: PC_PCC

Preamble:

The course covers the fundamental principles and techniques used in designing and analyzing algorithms. Students will learn how to analyze the performance of algorithms, measure their efficiency, and compare different algorithms based on their time and space complexity. The course is designed for students with a solid understanding of programming and data structures. By the end of the course, students will have a deep understanding of the principles of algorithm design and analysis and will be equipped with the tools and techniques necessary to develop efficient algorithms for a wide range of computational problems.

Pre-requisites:

Engineering Mathematics-III
Data Structures Lab

Course Objectives:

- To introduce the methods of designing and analyzing algorithms.
- Design and implement efficient algorithms for a specified application.
- Strengthen the ability to identify and apply suitable algorithms for the given real-world problem.
- Analyze worst-case running time of algorithms and understand fundamental algorithmic problems.

Course Outcomes:

At the end of the course, the students will be able to
CO1: Implement the algorithms using different approaches.
CO2: Analyze the complexities of various algorithms.
CO3: Apply and Analyze Greedy strategy to solve given problems.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	25	--	25	50

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Suggested List of Practical's:

Sr No.	Suggested Topic(s)
1.	Introduction: Selection sort, Insertion sort
2.	Divide and Conquer Approach: Finding Minimum and Maximum, Merge sort, Quick sort, Binary search
3.	Greedy Method Approach: Single source shortest path- Dijkstra Fractional Knapsack problem Job sequencing with deadlines Minimum cost spanning trees-Kruskal and Prim's algorithm
4.	Dynamic Programming Approach: Single source shortest path- Bellman Ford All pair shortest path- Floyd Warshall 0/1 knapsack Longest common subsequence
5.	Backtracking: N-queen problem Graph coloring

Text Books:

1. T. H. Cormen, C.E. Leiserson, R. L. Rivest, and C. Stein, "Introduction to algorithms", 2nd Edition, PHI Publication 2005.
2. Jon Kleinberg, Eva Tardos "Algorithm Design", Pearson Education.
3. Ellis Horowitz, Sartaj Sahni, S. Rajsekaran. "Fundamentals of computer algorithms" University Press.

Reference Books:

1. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGraw-Hill Edition.
2. S. K. Basu, "Design Methods and Analysis of Algorithm", PHI.

Course Name: Mini Project-I

Course Code: PRJ01

NEP Vertical Basket: ELC

Preamble:

Students will be acquainted with the process of identifying the needs and converting it into the problem. Third year students will be familiarized with the process of solving the problem in a group and applying basic engineering fundamentals to attempt solutions to the problems. This will inculcate the process of self-learning and research.

Pre-requisites:

All subjects they learned till TE and beyond.

Course Objectives:

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcomes:

Learner will be able to:

CO1: Identify problems based on societal /research needs and apply Knowledge and skill to solve societal problems in a group.
CO2: Develop interpersonal skills to work as member of a group or leader and Excel in written and oral communication.
CO3: Draw the proper inferences from available results through theoretical/ experimental/simulations and analyze the impact of solutions in societal and environmental context for sustainable development
CO4: Use standard norms of engineering practices
CO5: Demonstrate capabilities of self-learning in a group, which leads to lifelong learning
CO6: Demonstrate project management principles during project work.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	4	-	2

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	50	75

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall decide her/his assessment methodology based on the course's nature. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Guidelines for Mini Project:

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Internal Assessment:

- The review/ progress monitoring committee shall be constituted by head of department. The progress of mini project to be evaluated on continuous basis, minimum two reviews during the semester.

1. Review 1: First review shall be for finalization of problem and proposed solution
2. Review 2: Second review shall be for implementation and testing of solution.

- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of internal assessment marks for minor project shall be as below:

1. Marks awarded by guide/supervisor based on log book: 10
2. Marks awarded by review committee: 10
3. Quality of Project report: 05

Minor Project shall be assessed based on following criteria:

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness and Societal impact
6. Full functioning of working model as per stated requirements
7. Effective use of skill sets
8. Effective use of standard engineering norms
9. Contribution of an individual's as member or leader
10. Clarity in written and oral communication In case of minor project-I all criteria in generic may be considered for evaluation of performance of students in mini project.

End semester examination assessment:

- Report should be prepared as per the guidelines issued by the department.
- Minor Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Detailed Syllabus of Multidisciplinary Minor Courses

Course Name: Introduction to Bioinformatics

Course Code: MDMBI01

NEP Vertical_Basket: MDC_MDM

Preamble:

This course is designed with the objective of equipping students with a robust understanding of the integration between biology and computational science, key bioinformatics concepts, methodologies, and applications. Through a combination of theoretical knowledge and practical applications, students will develop a holistic understanding of how computational methods can enhance the comprehension of biological processes. It also emphasizes on real-world biological questions and research challenges, empowering them to make meaningful contributions to the rapidly evolving field of bioinformatics

Course Objectives:

- To enable learners to understand the basic principles of bioinformatics.
- Build foundational understanding of biology, types of biological data, and the role of computing in biology.

Course Outcomes:

Student will be able to:

CO1: Explain foundational molecular biology concepts and their relevance to bioinformatics, including DNA, RNA, proteins, and gene functions.

CO2: Access, compare, and utilize various biological databases and sequence file formats to retrieve and analyze genomic and proteomic data effectively.

CO3: Apply key sequence alignment algorithms and computational techniques to analyze biological sequences and construct phylogenetic relationships.

CO4: Implement bioinformatics algorithms and data structures to solve problems in genomics, proteomics, and systems biology, including gene prediction and motif discovery.

CO5: Evaluate current applications and emerging trends in bioinformatics, including personalized medicine, big data analytics, ethical issues, and the integration of AI/ML technologies in biological research.

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Tutorial	Theory	Tutorial
MDMBI01	3	1	3	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory (MDMBI01)	45	30	50	125

The assessment/evaluation guidelines for the courses of different credits are mentioned. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Basics of Molecular Biology	Structure and function of DNA, RNA, and proteins Central Dogma of Molecular Biology (Replication, Transcription, Translation) Codons and genetic code Types of genes (structural, regulatory) Mutations and their biological effects.	8
2	Biological Databases	Types: Primary, Secondary, Specialized databases, GenBank, EMBL, DDBJ – comparative study, UniProt, PDB, RefSeq, Ensembl, Sequence file formats (FASTA, GenBank, GFF, SAM/BAM), Querying biological databases (using NCBI Entrez, EBI search tools)	8
3	Sequence Analysis	Types of biological sequences: DNA, RNA, Protein,Pairwise and Multiple Sequence Alignment (MSA),Scoring matrices (PAM, BLOSUM),Tools: BLAST, FASTA, ClustalW, Applications: gene finding, phylogeny, structure prediction	8
4	Genomics & Human Genome Project	Genome organization and structure, Sequencing techniques: Sanger, Next Generation Sequencing (NGS), Nanopore, Applications: disease gene identification, forensic genomics, Human Genome Project: goals, achievements, ethical issues, Comparative genomics	12
5	Applications of Bioinformatics	Bioinformatics in personalized medicine, Drug discovery and vaccine design, Agriculture and animal genomics Role of AI/ML in bioinformatics	9
Total			**45**

Books and Resources:

1. Bioinformatics: Sequence and Genome Analysis by Mount D., Cold Spring Harbor Laboratory Press, New York. 2004
2. Bioinformatics- a Practical Guide to the Analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellellette, B.F., Wiley India Pvt Ltd. 2009
3. Introduction to bioinformatics by Teresa K. Attwood, David J. Parry-Smith. Pearson Education. 1999

Course Title: Foundations of Innovation and Entrepreneurship

Course Code: MDMIE01

NEP Vertical_Basket: MDC_MDM

Preamble:

This course provides a foundational understanding of how innovation emerges, how entrepreneurs identify and act on opportunities, and how new ventures can be developed to address real-world challenges. It explores the intersection of creativity, strategic thinking, and risk-taking, emphasizing both individual initiative and collaborative problem-solving.
Pre-requisites: NIL

Course Objectives:

- To introduce the foundational concepts of innovation and entrepreneurship.
- To build awareness of opportunity recognition, creativity, and idea validation.
- To expose students to business modelling and startup ecosystems.

Course Outcomes:
Students will be able to:
CO1: Understand key entrepreneurial trends and innovation drivers
CO2: Apply ideation tools to enhance entrepreneurial ideas.
CO3: Create basic business models using modern tools.
CO4: Evaluate entrepreneurial case studies and pitch early-stage ideas and take critical feedback.

Course Scheme:

Course Code	Contact Hours		Credits Assigned	
	Theory	Tutorial	Theory	Tutorial
MDMBI01	3	1	3	1

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Theory	45	30	50	125

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Introduction to Entrepreneurship	• Definition, importance, and scope • Types of entrepreneurs • Entrepreneurial mindset and characteristics	8
2	Innovation Basics	• Types of innovation (product, process, business model) • Disruptive vs. incremental innovation Design Thinking fundamentals	8
3	Idea Identification & Evaluation	• Creativity and ideation tools (brainstorming, SCAMPER, mind-mapping) • Problem-solving frameworks • Validating ideas	10
4	Business Case presentation	• Business Model Canvas • Value Proposition Design • Customer Segments and Customer Discovery	6
5	Leveraging the Entrepreneurial Ecosystem	• Role of incubators, accelerators, and funding bodies • Startup India, Atal Innovation Mission, etc	7
		Total	**45**

Tutorials (1 Credit):

- Case studies on startups
- Group exercises on ideation
- Hands-on practice with the Business Case presentation
- Ideation workshops
- Business culture studies exercises
- Group discussion and presentations

Reference books:

- Steve Blank, The Startup Owner's Manual, K&S Ranch Publishing Inc
- Alexander Osterwalder, Business Model Generation, John Wiley and Sons
- Peter F. Drucker, Innovation and Entrepreneurship, HarperCollins Publishers Inc

Course Name: Introduction to Business Development and Marketing Principles

Course Code: MDMBD01

NEP Vertical_Basket: MDC_MDM

Preamble:
The objective of this course is to introduce engineering students to the fundamentals of business development and marketing using a customer centric lens. Students will learn how to conceptualize a basic business idea, understand market needs, and align engineering innovations with customer demand.

Pre-requisites:
None

Course Objectives:

- Understand basic business structures and concepts.
- Identify customer needs and conduct basic market research.
- Learn fundamentals of marketing strategy in a technology-driven world.
- Appreciate the role of engineering in business innovation.

Course Outcomes:
Students will be able to:

CO1: Explain key concepts in business development and marketing relevant to engineers.
CO2: Conduct simple market research and competitor analysis for a tech-based idea.
CO3: Draft a basic value proposition and elevator pitch.
CO4: Identify business opportunities through innovation in telecom and electronics domains.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	1(Tutorial)	3	1(Tutorial)

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Theory	45	30	50	125

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Foundations of Business	Types of businesses, vision-mission-goals, legal forms of business, introduction to entrepreneurship.	8
2	Marketing Essentials	Needs vs wants, Segmentation, targeting, positioning, Marketing mix (4Ps), digital vs traditional marketing.	8
3	Customer Focus	Basics of customer journey, personas	7
4	Technology Product Planning	Basics of product lifecycle, innovation funnel, idea screening.	10
5	Market Research Basics	Research Types, Research steps, Sampling,, Surveys, interviews, SWOT, competitor analysis.	6
6	Business Idea Pitch	Business idea pitch, value proposition canvas, storytelling.	6
		Total	**45**

Textbooks:

1. Marketing Management by Kotler

Reference Books:

1. Marketing Basics PDF by MIT OpenCourseWare

Course Name: Fundamentals of Robotics and Control

Course Code: MDMRB01

NEP Vertical_Basket: MDC_MDM

Preamble:

This course introduces the foundational principles of robotics, including kinematics, dynamics, and control systems. The course explores real-world robotic applications and the growing role of automation in modern industries. Students will gain hands-on experience with robotic systems and process automation tools. The course integrates Robotic Process Automation (RPA) to bridge physical and digital automation domains.

Course Objectives:

- Understand the foundational principles of robotics, including kinematics, dynamics, and control of robotic systems.
- Apply basic control strategies such as PID to robotic manipulators and mobile robots
- Explore the role of Robotic Process Automation (RPA) as a complementary software-based automation technique and build simple RPA workflows.

Pre-requisites:

1. Engineering Mathematics-I
2. Engineering Mathematics-II
3. Structured Programming
4. Object Oriented Programming

Course Outcome:

The students will be able to:

CO1: Explain the components and types of robotic systems and their applications.
CO2: Derive and apply forward and inverse kinematics for simple manipulators.
CO3: Analyze and implement feedback control systems, including PID controllers
CO4: Simulate basic robotic arm motion and trajectory control using software tools..
CO5: Describe the fundamentals of Robotic Process Automation (RPA) and its uses in industry.
CO6: Develop a basic RPA workflow to automate a simple rule-based software task.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
3	2	3	1

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Theory	45	30	50	125

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Module Contents	No. of Hours
01	Introduction to Robotics	Types of robots: manipulators, mobile robots, humanoids Robot anatomy: joints, links, actuators, sensors Applications in manufacturing, healthcare, and services	06
02	Kinematics of Robotic Manipulators	Coordinate systems and transformations, Denavit–Hartenberg (D-H) parameters, Forward and inverse kinematics for 2-DOF and 3-DOF arms	09
03	Dynamics and Trajectory Planning	Basic concepts in robot dynamics (torque, inertia – overview), Joint and Cartesian trajectory planning, Linear and cubic interpolation	06
04	Control of Robotic Systems	Introduction to control systems, PID control: tuning, implementation, and real-time control, Stability and feedback concepts	08
05	Introduction to Robotic Process Automation	What is RPA, Difference from physical robotics, Components of an RPA system: bots, orchestrators, recorders, Overview of popular RPA tools (e.g., UiPath)	06
06	RPA Workflow Design and Integration	Creating simple bots to automate tasks (e.g., Excel, web forms), Control structures, data handling, and triggers in RPA, Conceptual integration: using RPA to initiate physical robot actions	10
Total			**45**

Suggested List of Value-Added Home Assignments:

1. Research a real-life robotic system (e.g., Da Vinci surgical robot, warehouse AGVs, Boston Dynamics' Spot). Analyze its components, sensing and actuation methods, and control logic. Propose a reconfiguration or redesign for a different application.
2. Design a 2-DOF or 3-DOF manipulator in MATLAB or Python. Simulate a simple pick-and-place routine.

3. Design a time-optimized trajectory considering joint velocity and acceleration limits for trajectory planning for a Robotic Painter
4. Implement a PID controller to stabilize an inverted pendulum model. Simulate using MATLAB/Python
5. Identify a repetitive digital task in your daily academic/work life. Automate them using tools
6. Create an RPA bot that responds to an email, form submission, or file upload.

Reference Books / Articles

1. Robert Shilling, Fundamentals of Robotics-Analysis and control, Prentice Hall of India, 2003.
2. John J. Craig, Introduction to Robotics–Mechanics &Control Pearson Education, India, Third Edition, ,2009.
3. Katsuhiko Ogata, Modern Control Engineering
4. Alok Mani Tripathi, Learning Robotic Process Automation
5. Fu, Gonzales and Lee, Robotics, Robotics, McGraw Hill, SecondEdition,2011.
6. Staughard, Robotics and AI, Prentice Hall of India.
7. Grover, Wiess, Nagel, Oderey Industrial Robotics, , McGraw Hill.
8. Walfram Stdder, Robotics and Mechatronics, Mc Graw Hill, New York 2008.
9. Saeed B Niku, Introduction to Robotics, Pearson Education.
10. Mittal, Nagrath, Robotics and Control, Tata McGraw Hill publications

Detailed Syllabus of Third Year Semester - VI

Course Name: Theory of Computer Science

Course Code: PCEC12T

NEP Vertical Basket: PC_PCC

Preamble:
This course introduces students to formal language and automata theory. It covers different types of grammars and automata of different powers that are required to recognize languages defined by the grammars.

Pre-requisites:

BS05 (Engineering Mathematics 3)

Course Objectives:
• Acquire conceptual understanding of fundamentals of grammars and languages.
• Build concepts of theoretical design of deterministic and non-deterministic finite automata and push down automata.
• Develop understanding of different types of Turing machines and applications.

Course Outcomes:
Learner will be able to:
CO1: Express rules in mathematical form (grammar).
CO2: Classify the problem into appropriate type of grammar.
CO3: Apply equivalence theory to recognize power of different automata.
CO4: Design Automata to meet the required specifications.
CO5: Create a tool that designs automata for a given grammar.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Tutorial	Theory	Tutorial
2	1	2	1

Assessment guidelines:

Head of Learning	**ISA**	**MSE**	**ESE**	**Total**
Theory + Tutorial	40	20	40	100

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Fundamentals of Automata Theory	Basic Mathematical Fundamentals: Set Theory, Logic, Relations and Functions.	4
2	Introduction to Language & Finite Automata	Concepts: Symbol, Alphabet, Language and Grammar. Types of Grammar and Automata. Deterministic: 5-tuple representation of DFA. Designing DFA for Regular Language. Minimization of DFA. Non-Deterministic: 5-tuple representation of NFA with epsilon moves and NFA without epsilon moves. Equivalence of language recognized by NFA and DFA.	6
3	Regular Language and Grammar	Regular Expression and Regular Grammar. Equivalence of FA and Regular Expression. Properties of Regular Sets/ Languages. Classifying language as Regular and Non-regular.	4
4	Context Free and Sensitive Languages	Concepts: CFG, CFL, Derivations and Ambiguity. CFL as a superset of Regular. Normal Forms (CNF and GNF). Properties of CFL.	6
5	Push-Down Automata	7-tuple Deterministic PDA. Deterministic and NonDeterministic PDA. Equivalence of NPDA and CFL.	4
6	Turing Machine	Basic 7-tuple Turing Machine (TM). TM as acceptor & generator. Recursive and RE Languages. Decidability & Undecidability.	6
Total			**30**

Suggestion for list of Tutorials:

1. At-least one tutorial on each module. Recommended to add additional tutorials for module 3, 5 and 7.
2. Questions should be short and conceptual only. Each tutorial should be designed worth 2 Marks. Required to be solvable in 5 to 10 mins.
3. Tutorial to have major questions mapping to level 1 of Blooms Taxonomy (Understanding) and few questions mapping to level 2 of Blooms Taxonomy (Applying).

Text Books:

1. John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman. Introduction to Automata Theory, Languages and Computation. Pearson Education. 2008.
2. Michael Sipser. Introduction to the Theory of Computation. Thomson Course Technology. 2012.
3. Peter Linz. An Introduction to Formal Languages and Automata. Jones and Bartlett Student Edition. 2016.

Course Name: Computer Network

Course Code: PCEC13T

NEP Vertical Basket: PC_PCC

Preamble:

This course aims to give students an overview of the concepts and fundamentals of computer networks. It covers protocol layering, enabling students to analyze network performance. Additionally, the course provides insights into the functions of the OSI and TCP/IP models and various routing protocols.

Pre-requisites:

Digital Circuit Design
Digital Electronics
Electronic Devices and circuits

Course Objectives:

1. To introduce concepts and fundamentals of data communication and computer networks.
2. To explore the inter-working of various layers of OSI.
3. To explore the issues and challenges of protocols design while delving into TCP/IP protocol suite.
4. To assess the strengths and weaknesses of various routing algorithms.
5. To understand various transport layer and application layer protocols.

Course Outcomes:

Students will be able to:

1. Demonstrate the concepts of data communication and compare ISO - OSI model with TCP/IP model.
2. Explore different design issues at data link layer.
3. Design the network using IP addressing and subnetting / super netting schemes.
4. Analyze various routing algorithms and protocols at network layer.
5. Analyze transport layer protocols and congestion control algorithms.
6. Explore protocols at application layer.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	**ISA**	**MSE**	**ESE**	**Total**
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Computer Networks	Introduction to computer network, network application, (Interconnection networking devices), Network topology, protocol hierarchies, design issues for the layers, connection oriented and connectionless services. Revisiting OSI Model & TCP/IP Model.	4
2	Data Link Layer	Data Link Layer 2.1 DLL Design Issues (Services, Framing, Error Control, Flow Control), Error Detection and Correction (Hamming Code, CRC, Checksum) , Elementary Data Link protocols , Stop and Wait, Sliding Window(Go Back N, Selective Repeat), HDLC 2.2 Medium Access Control sublayer Channel Allocation problem, Multiple access Protocol(Aloha, Carrier Sense Multiple Access (CSMA/CD), Local Area Networks - Ethernet (802.3)	8
3	IP Addressing & Network Layer	IPv4 Addressing (classful and classless), Subnetting, Super netting design problems, IPv4 Protocol, Network Address Translation (NAT). IPv6 Addressing, Transition from IPV4 to IPV6	8
4	Routing Protocols	Shortest Path (Dijkstra's), Link state routing, Distance Vector Routing	4
5	Transport Layer	Connection management (Handshake), UDP, TCP, TCP state transition, TCP timers. TCP Flow control (sliding Window), TCP Congestion Control: Slow Start.	4
6	Application Layer	Protocols: DNS, HTTP, SMTP, Telnet, FTP, DHCP	2
Total			**30**

Textbooks:

1. Behrouz A. Forouzan, Forouzan Mosharrat , Computer Networks A Top down Approach, Mc Graw Hill education.
2. Andrew S Tanenbaum, Computer Networks -, 4th Edition, Pearson Education.

Reference Books:

1. Keshav, An Engineering Approach to Computer Networks, 2nd Edition, Pearson Education.
2. B. A. Forouzan, "TCP/IP Protocol Suite", Tata McGraw Hill edition, Third Edition.

Course Name: Computer Networks Lab

Course Code: PCEC13P

NEP Vertical Basket: PC_PCC

Preamble:

This course is to provide students with an overview of the concepts and fundamentals of computer networks.

Pre-requisites:

Digital Circuit Design Lab
Digital Electronics Lab

Course Objectives:

1. To practically explore OSI layers and understand the usage of simulation tools.
2. To analyze, specify and design the topological and routing strategies for an IP based networking infrastructure.
3. To identify the various issues of a packet transfer from source to destination, and how they are resolved by the various existing protocols.

Course Outcomes:
Learner will be able to:
CO1: Execute and evaluate network administration commands and demonstrate their use in different network scenario
CO2: Demonstrate the installation and configuration of network simulator.
CO3: Demonstrate and measure different network scenarios and their performance behavior. CO4: Implement the socket programming for client server architecture.
CO5: Analyze the traffic flow of different protocols
CO6: Design a network for an organization using a network design tool

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the

above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Practicals

Learners are expected to perform practicals based on the following suggested topics.

Sr No	Suggested Topic(s)
1	Study, understand and perform various networking commands: Ping, Tracert, trace route, ipconfig, ifconfig, nslookup, netstat
2	Designing Network Layout
3	Program for Error Detection
4	Program for Error Correction
5	Program on IP Addressing
6	Case study on Subnetting and Super netting
7	Socket Programming
8	Chat Application
9	Installation and configuration of Wireshark tool Study the packet transmission using Wireshark and understand/visualize the IP protocol
10	Cisco Packet Tracer

Textbooks:

1. Behrouz A. Forouzan, Forouzan Mosharrat , Computer Networks A Top down Approach, Mc Graw Hill education.
2. Andrew S Tanenbaum, Computer Networks -, 4th Edition, Pearson Education.

Reference Books:

1. Keshav, An Engineering Approach to Computer Networks, 2nd Edition, Pearson Education.
2. B. A. Forouzan, "TCP/IP Protocol Suite", Tata McGraw Hill edition, Third Edition.

Course Name: Analog & Digital Communications

Course Code: PCEC14T

NEP Vertical Basket: PC_PCC

Preamble:

In this course students will learn the fundamental principles and techniques behind the transmission of analog & digital signals. Through a blend of theoretical concepts and practical applications, students will explore the evolution from traditional analog to modern digital communication systems. Topics include modulation, coding, multiplexing, noise analysis, and coding. Emphasis will be placed on understanding signal propagation, channel capacity, and the impact of noise on communication quality. By the end, students will possess a solid foundation in both analog and digital communication principles, preparing them for diverse real-world challenges in the field.

Pre-requisites:

- BS06 (Engineering Mathematics-III)
- BS08 (Engineering Mathematics-IV)
- EC06 (Signals and Systems-IV)

Course Objectives:

- To understand the fundamental concepts and methods employed in analog and digital communications.
- To learn different modulation techniques used in analog and digital, and how they're applied in communication systems.
- To explore baseband and bandpass communication methods, as well as various coding techniques used in data transmission.
- To analyze the effect of noise in communication systems and learn about different multiplexing techniques utilized in transmitting multiple signals over a single channel.

Course Outcomes:

Learner will be able to:
CO1: Understand the fundamental principles and components of communication systems.
CO2: Apply knowledge of basic analog communication systems.
CO3: Evaluate the effects of noise on communication systems.
CO4: Interpret the principles governing digital communication systems.
CO5: Create and execute error control coding schemes to enhance communication reliability.
CO6: Investigate the practical applications of multi-user radio communication through case studies and applications.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Introduction to communication systems	• Basic elements of a communication system (source, transmitter, channel, receiver, destination) • Signal representation: time domain and frequency domain (Fourier Series & Fourier Transform) • Introduction to communication models	6
2	Analog communication systems	• Amplitude Modulation (AM): Double-sideband suppressed carrier (DSB-SC) modulation, Single-sideband (SSB) modulation and Vestigial sideband (VSB) modulation, AM receivers: envelope detector. • Angle Modulation (FM): Wideband FM (WBFM) and Narrowband FM (NBFM), FM receivers: discriminator.	6
3	Noise Analysis in communication systems	• Introduction to noise sources (thermal noise, shot noise) • Signal-to-Noise Ratio (SNR) and its importance. • Noise analysis in communication systems • Inter symbol inference, Inter channel interference	3

4	Digital communication systems	• Introduction to digital signals and baseband transmission • Sampling theorem and Nyquist rate • Quantization and pulse code modulation (PCM) • Line coding techniques: Unipolar, Bipolar, Polar,RZ, NRZ, Manchester, Differential Manchester • Digital modulation techniques: Binary Phase Shift Keying (BPSK), Binary Amplitude Shift Keying (BASK), Binary Frequency Shift Keying (BFSK) Quadrature Phase Shift Keying (QPSK), Quadrature Amplitude Phase Shift Keying (QAPSK)	8
5	Error control coding	• Error control coding: Channel Capacity, Linear Block Codes, Cyclic Codes – ARQ Techniques • Simulation of error control coding schemes.	4
6	Multi-user radio communication	• Global System for Mobile Communications (GSM) – Code Division Multiple Access (CDMA) – Cellular • Concept and Frequency Reuse – Channel Assignment and Handover Techniques – Overview of Multiple Access Schemes – Satellite Communication, Optical Fiber Communication, Mobile communication	3
Total			**30**

Textbooks:

1. B.P. Lathi "Modern Digital and analog Communication system" Third Edition, OXFORD.
2. Taub and Schilling, "Principles of communication systems", Tata McGraw Hill.
3. Simon Haykin, "Communication Systems", 4th Edition, John Wiley & Sons.
4. Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd Edition.

Reference Books:

1. Wayne Tomasi, "Electronics communication systems" Pearson Education, Third Edition, 2001.
2. Roy Blake, "Electronics communication system,", Thomson learning, Second Edition.
3. Blake, "Electronic Communication Systems", Thomson Delmar Publications, 2002.
4. B. Sklar, "Digital Communication Fundamentals and Applications"2nd edition
5. Robert J. Schoenbeck, "Electronics communications modulation and transmission"
6. Lean W couch, "Digital and Analog communication system", Pearson Education, Sixth Edition
7. Roddy Coolen, "Electronic Communications" PHI

Course Name: Analog & Digital Communications Lab

Course Code: PCEC14P

NEP Vertical Basket: PC_PCC

Preamble:

In this course students will learn the fundamental principles and techniques behind the transmission of analog & digital signals. Through a blend of theoretical concepts and practical applications, students will explore the evolution from traditional analog to modern digital communication systems. Topics include modulation, coding, multiplexing, noise analysis, and coding. Emphasis will be placed on understanding signal propagation, channel capacity, and the impact of noise on communication quality. By the end, students will possess a solid foundation in both analog and digital communication principles, preparing them for diverse real-world challenges in the field.

Pre-requisites:

- BS06 (Engineering Mathematics-III)
- BS08 (Engineering Mathematics-IV)
- EC06 (Signals and Systems-IV)

Course Objectives:

- To simulate different modulation techniques used in analog and digital, and how they're applied in communication systems.
- To explore various coding techniques used in data transmission.
- To analyze the effect of noise in communication systems and learn about different multiplexing techniques utilized in transmitting multiple signals over a single channel.

Course Outcomes:

Learner will be able to:
CO1: Apply knowledge of basic analog communication systems.
CO2: Simulate the principles governing digital communication systems.
CO3: Create and execute error control coding schemes to enhance communication reliability.
CO4: Investigate the practical applications of multi-user radio communication through case studies and applications.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	25	--	25	050

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Suggested List of Practical's:

Sr No.	Suggested Topic(s)
11.	Amplitude modulation - generation and detection
12.	Frequency modulation generation and detection
13.	Simulation of AM/ FM receiver
14.	Signal sampling and reconstruction
15.	PCM coding and decoding
16.	Line Coding
17.	Linear Block Codes
18.	BPSK Modulation & Demodulation
19.	BFSK Modulation & Demodulation
20.	BASK Modulation & Demodulation
21.	QPSK Modulation & Demodulation

Useful Tools and Laboratory: -

1. NPTEL MOOC Courses
2. Swayam Portal AICTE
3. National Digital Library, IIT KGP.
4. Virtual Lab by IIT Bombay.
5. MATLAB
6. SCILAB
7. LABVIEW
8. Various Analog and Digital Communication Trainers.

Text Books:

1. B.P. Lathi "Modern Digital and analog Communication system" Third Edition, OXFORD.
2. Taub and Schilling, "Principles of communication systems", Tata McGraw Hill.
3. Simon Haykin, "Communication Systems", 4th Edition, John Wiley & Sons.
4. Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd Edition.

Reference Books:

1. Wayne Tomasi, "Electronics communication systems" Pearson Education, Third Edition, 2001.
2. Roy Blake, "Electronics communication system,", Thomson learning, Second Edition.
3. Blake, "Electronic Communication Systems", Thomson Delmar Publications, 2002.
4. B. Sklar, "Digital Communication Fundamentals and Applications"2nd edition
5. Robert J. Schoenbeck, "Electronics communications modulation and transmission"
6. Lean W couch, "Digital and Analog communication system", Pearson Education, Sixth Edition
7. Roddy Coolen, "Electronic Communications" PHI

Detailed Syllabus of AIML Track – Sem V & VI

Course Name: Artificial Intelligence

Course Code: PEEC01T

NEP Vertical Basket: PC_PEC

Preamble:

Intelligent machines have replaced human capabilities in many areas. Artificial intelligence is the intelligence exhibited by machines or software. It emphasizes creating intelligent machines that work and react like humans.

Pre-requisites:

NIL

Course Objectives:

1. Understand Artificial Intelligence
2. Know and use various problem-solving methods
3. Acquire and use knowledge representation methods in AI
4. Understand and design Artificial intelligence Agents
5. Know and identify AI applications
6. Design and apply Artificial Intelligence in community

Course Outcomes:

Learner will be able to:

CO1: To understand the basics of Artificial Intelligence

CO2: To know and use various problem-solving methods

CO3: To acquire and use knowledge representation methods in AI

CO4: To understand and design Artificial intelligence Agent

CO5: To know and identify AI applications

CO6: To design and apply Artificial Intelligence in community

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall decide her/his assessment methodology based on the course's nature. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Artificial Intelligence	• Artificial Intelligence Introduction, Intelligent systems • Categorization of Intelligent Systems • Characteristics of AI • Current Trends in AI	4
2	Intelligent Agents	• Agents and Environment, Structure of Agents, Types of agents, Learning agent, • Agent communication • Negotiation and Bargaining • Argumentation among Agents • Trust and Reputation in Multi-agent systems	5
3	Problem Solving Methods	• Uninformed search Breadth First Search, Depth First Search, Depth First iterative deepening, • Informed Search Greedy best first, A*, Heuristic search • Adversarial Search Game playing, alpha beta pruning, Min-Max search • Local search algorithms and optimization Hill climbing search, Genetic algorithms,	6
4	Knowledge Representation	• Knowledge Representation, brief overview of propositional logic, FOL syntax and semantic, forward chaining and backward chaining • Unification, resolution, • Uncertain knowledge and Engineering: knowledge in uncertain domain, semantics of belief network, simple inference in belief network	6
5	Planning and Learning	• Planning: Planning problem, Partial order planning, Hierarchical planning, Conditional planning • Learning: Forms of Learning, Theory of learning, PAC learning, Introduction to statistical learning	5
6	Artificial Intelligence Applications with Real Time USECASE	Students are supposed to study any AI Application and provide insights about the concepts used in respective application.	4
Total			**30**

Textbooks:

1. Artificial Intelligence: A Modern Approach (AIMA) is a university textbook on artificial intelligence, written by Stuart J. Russell and Peter Norvig.
2. S. Russel and P. Norvig, "Artificial Intelligence – A Modern Approach", Second Edition, Pearson Education

Reference Books:

1. David Poole, Alan Mackworth, Randy Goebel," Computational Intelligence: a logical approach", Oxford University Press.
2. G. Luger, "Artificial Intelligence: Structures and Strategies for complex problem solving", Fourth Edition, Pearson Education.
3. J. Nilsson, "Artificial Intelligence: A new Synthesis", Elsevier Publishers.

Course Name: Artificial Intelligence Lab

Course Code: PEEC01P

NEP Vertical Basket: PC_PEC

Preamble:

Intelligent machines have replaced human capabilities in many areas. Artificial intelligence is the intelligence exhibited by machines or software. It emphasizes creating intelligent machines that work and react like humans. AI labs will help to understand these concepts with practical experiments.

Pre-requisites:

NIL

Course Objectives:

- Understand Artificial Intelligence
- Know and use various problem-solving methods
- Acquire and use knowledge representation methods in AI
- Understand and design Artificial intelligence Agents
- Know and identify AI applications
- Design and apply Artificial Intelligence in community

Course Outcomes:

Learner will be able to:

CO1: To understand and conceptualize basic ideas and techniques in artificial Intelligence

CO2: To know and use various problem-solving methods

CO3: To acquire and choose appropriate knowledge representation methods in AI

CO4: To understand and design Artificial intelligence Agents

CO5: To know and identify AI applications

CO6: To design and develop Artificial Intelligence Applications in real world scenarios

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

Suggested List of Practicals:

Sr No.	Title of Practicals
1	One case study on AI applications published in IEEE/ACM/ Springer Journals
2	Program on uninformed search methods (BFS)
3	Program on uninformed search methods (DFS)
4	Program on informed search methods (A *)
5	Program on game playing assignments (Minmax)

6	Program on First order logic
7	Project (Develop any small AI Application)

Course Name: Soft Computing

Course Code: PEEC05T

NEP Vertical Basket: PC_PEC

Preamble:

Soft computing is an emerging approach to computing based on some biological inspired methodologies such as genetics, evolution, ant's behaviors, particles swarming, human nervous systems, etc. Now, soft computing is the only solution when we don't have any mathematical modeling of problem solving (i.e., algorithm), need a solution to a complex problem in real time, easy to adapt with changed scenario and can be implemented with parallel computing. It has enormous applications in many application areas such as medical diagnosis, computer vision, handwritten character reconditions, pattern recognition, machine intelligence, weather forecasting, network optimization, VLSI design, etc.

Pre-requisites:

- Engineering Mathematics (All Semesters)

Course Objectives:

After completing this course, you will be able to learn:

- Fuzzy logic and its applications.
- Artificial neural networks and its applications.
- Solving single-objective optimization problems using GAs.
- Solving multi-objective optimization problems using Evolutionary algorithms (MOEAs).
- Applications of Soft computing to solve problems in varieties of application domains.

Course Outcomes:

Learner will be able to learn:
CO1: Explain the fundamentals of soft computing, its constituents, and its adaptability.
CO2: Apply fuzzy set theory and design membership functions for imprecise data.
CO3: Develop fuzzy inference systems using Mamdani and Sugano models for decision-making.
CO4: Solve optimization problems using genetic algorithms and their operators.
CO5: Implement neural network algorithms for supervised and unsupervised learning tasks.
CO6: Design hybrid systems like ANFIS by integrating neural networks and fuzzy logic.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Introduction to Soft Computing	Soft computing Constituents, Characteristics of Neuro Computing and Soft Computing, Difference between Hard Computing and Soft Computing, Concepts of Learning and Adaptation.	4
2	Fuzzy Set Theory	Fuzzy Sets, Fuzzy relations, Fuzzification and Defuzzification. Features of the membership Functions, Fuzzy Max-Min and Max-Product Composition	4
3	Fuzzy Rules, Reasoning and Inference System	Fuzzy Rules: Fuzzy If-Then Rules, Fuzzy Reasoning Fuzzy Inference System (FIS): Mamdani FIS, Sugano FIS, Comparison between, Mamdani and Sugano FIS	4
4	Genetic Algorithm	An Introduction to genetic Algorithms: Genetic Algorithms Mathematical Foundations, Schemata Revisited Implementation of a Genetic Algorithm: Data Structures, Reproduction, Crossover, and Mutation, Algorithm for Handwriting Recognition Using GA Generation of Graph, Fitness Function of GA, Generation of Graph Results of Handwriting Recognition, Effect of Genetic Algorithms, Distance Optimization, Style Optimization, Solving single-objective optimization problems using GA, Multi-objective Optimization Problem Solving	6
5	Neural Networks	Basics of Neural Networks: Introduction to Neural Networks, Biological Neural Networks, McCulloch Pitt model Supervised Learning algorithms: Perceptron (Single Layer, Multi-layer), Linear separability, Delta learning rule, Back Propagation algorithm, Un-Supervised Learning algorithms: Hebbian Learning, Winner take all, Self Organizing Maps, Learning Vector Quantization.	8
6	Hybrid system	Introduction to Hybrid Systems, Adaptive Neuro Fuzzy Inference System (ANFIS)	4
Total			**30**

Textbooks:

1. Principles of Soft Computing, S.N. Sivanandam, S.N. Deepa, Willey, 2nd
2. An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press
3. Neural Networks, Fuzzy Logis and Genetic Algorithms : Synthesis, and Applications, S. Rajasekaran, and G. A. Vijayalakshmi Pai, Prentice Hall of India
4. Fuzzy Logic with Engineering Applications (3rd Edn.), Timothy J. Ross, Willey

Reference Books:

1. Practical Genetic Algorithms, Randy L. Haupt and sue Ellen Haupt, John Willey & Sons, 2002.
2. Genetic Algorithms In Search, Optimization And Machine Learning, David E. Goldberg, Pearson Education
3. Fuzzy Logic: A Pratical approach, F. Martin, , Mc neill, and Ellen Thro, AP Professional

Course Name: Soft Computing Lab

Course Code: PEEC05P

NEP Vertical Basket: PC_PEC

Preamble:

Soft computing provides a reliable solution when we don't have any mathematical modeling of problem solving (i.e., algorithm), need a solution to a complex problem in real time, easy to adapt with changed scenario and can be implemented with parallel computing. It has enormous applications in many application areas such as medical diagnosis, computer vision, handwritten character reconditions, pattern recognition, machine intelligence, weather forecasting, network optimization, VLSI design, etc

Pre-requisites:

- Engineering Mathematics (All Semesters)

Course Objectives:

After completing this course, you will be able to learn:

- Fuzzy logic and its applications.
- Artificial neural networks and their applications.
- Solving single-objective optimization problems using GAs.
- Solving multi-objective optimization problems using Evolutionary algorithms (MOEAs).
- Applications of Soft computing to solve problems in varieties of application domains.

Course Outcomes:

Learner will be able to learn:
CO1: Explain the fundamentals of soft computing, its constituents, and its adaptability.
CO2: Apply fuzzy set theory and design membership functions for imprecise data.
CO3: Develop fuzzy inference systems using Mamdani and Sugeno models for decision-making.
CO4: Solve optimization problems using genetic algorithms and their operators.
CO5: Implement neural network algorithms for supervised and unsupervised learning tasks.
CO6: Design hybrid systems like ANFIS by integrating neural networks and fuzzy logic.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	25	--	25	50

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Suggested List of Practical's:

Sr No.	Suggested List of Experiments
1.	Study of Fuzzy set and Theory
2.	Implementing basic fuzzy Operations
3.	Implementation of fuzzy set close to N
4.	Study of the Fuzzy toolbox.
5.	Implementing Train Controller problem
6.	Implementing Washing machine problem
7.	Implementing Water purification problem
10.	Implementing Tipper problem
11.	Implementing the Perceptron learning rule.
12.	Implementing the Curve Fitting using Genetics algorithm.
13.	Development of an Adaptive Neuro-Fuzzy Inference System (ANFIS)
14.	Backpropagation Algorithm for Multilayer Perceptron

Text Books:

1. Principles of Soft Computing, S.N. Sivanandam, S.N. Deepa, Willey, 2nd
2. An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press
3. Neural Networks, Fuzzy Logis and Genetic Algorithms : Synthesis, and Applications, S. Rajasekaran, and G. A. Vijayalakshmi Pai, Prentice Hall of India
4. Fuzzy Logic with Engineering Applications (3rd Edn.), Timothy J. Ross, Willey

Reference Books:

1. Practical Genetic Algorithms, Randy L. Haupt and sue Ellen Haupt, John Willey & Sons, 2002.
2. Genetic Algorithms In Search, Optimization And Machine Learning, David E. Goldberg, Pearson Education.
3. Fuzzy Logic: A Practical approach, F. Martin, , Mc neill, and Ellen Thro, AP Professional.

Course Name: Machine Learning

Course Code: PEEC09T

NEP Vertical Basket: PC_PEC

Preamble:
This course is designed to provide students with a comprehensive understanding of fundamental concepts, algorithms, and techniques in machine learning. Through a combination of theoretical lectures, hands-on lab sessions, and real-world projects, students will gain the necessary knowledge and skills to apply machine learning effectively in practical scenarios.

Pre-requisites:

- EC09 (Python Programming)

Course Objectives:

- To understand Machine Learning Concepts.
- To apply various data processing techniques.
- To understand and apply supervised and unsupervised algorithm concepts.
- To apply knowledge of machine learning to solve real-world problems.

Course Outcomes:

Students will be able to:
CO1: Understand the fundamental concepts and scope of Machine Learning.

CO2: Apply various techniques of Data Preprocessing to clean, transform, and prepare raw data.

CO3: Analyse and interpret the concepts and model representations of Linear Regression and Logistic Regression.

CO4: Compare decision trees, random forests, and ensemble methods for supervised learning.

CO5: Utilize clustering algorithms along with dimensionality reduction techniques to identify patterns and reduce the dimensionality of data.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head	ISA	MSE	ESE	Total
Theory	15	20	40	75

Detailed Syllabus:

Module no	Module name	Content	No of Hours
1	Introduction to Machine Learning	Introduction to ML, Definition and scope of Machine Learning, Types of Machine Learning: Supervised, Unsupervised, Reinforcement Learning, Applications of Machine Learning in various domains, Steps in Developing Machine Learning Applications	4
2	Data Preprocessing	Importance of Data Preprocessing, Identifying and Handling Missing Data, Feature Scaling – Standardization, Normalization, Robust Scaling, Encoding Categorical Data - Label Encoding, One-Hot Encoding etc.	6
3	Supervised Learning-1	Linear Regression- concepts and model representation, Logistic Regression- concepts and model representation, and Evaluation metrics for linear regression - Mean Absolute Error (MAE), Mean Squared Error (MSE), Root Mean Squared Error (RMSE), R-squared (R^2) Score.	6
4	Supervised Learning-2	Decision trees, random forests, and ensemble methods.	6
5	Unsupervised Learning	Clustering algorithms - K-means, Hierarchical, Dimensionality Reduction – Principal Component Analysis (PCA).	8
Total			**30**

Textbooks:

1. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", Cambridge University Press.
2. Hastie, Tibshirani, Friedman, "Introduction to Statistical Machine Learning with Applications in R", Springer, 2nd Edition, 2012
3. Peter Harrington, "Machine Learning in Action", DreamTech Press.

Reference Books:

1. Ethem Alpaydin, "Introduction to Machine Learning"
2. C. M. Bishop, "Pattern Recognition and Machine Learning"

Course Name: Machine Learning Lab

Course Code: PEEC09P

NEP Vertical Basket: PC_PEC

Preamble:
This course is designed to provide students with a comprehensive understanding of fundamental concepts, algorithms, and techniques in machine learning. Through a combination of theoretical lectures, hands-on lab sessions, and real-world projects, students will gain the necessary knowledge and skills to apply machine learning effectively in practical scenarios.

Pre-requisites:

- EC09 (Python Programming)

Course Objectives:

- To understand Machine Learning Concepts.
- To apply various data processing techniques.
- To understand and apply supervised and unsupervised algorithm concepts.
- To apply knowledge of machine learning to solve real-world problems.

Course Outcomes:

CO1: Understand the fundamental concepts and scope of Machine Learning.

CO2: Apply various techniques of Data Preprocessing to clean, transform, and prepare raw data.

CO3: Analyse and interpret the concepts and model representations of Linear Regression and Logistic Regression.

CO4: Compare decision trees, random forests, and ensemble methods for supervised learning.

CO5: Utilize clustering algorithms along with dimensionality reduction techniques to identify patterns and reduce the dimensionality of data.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Scheme:

Head	**ISA**	**MSE**	**ESE**	**Total**
Practical	25	-	25	50

Suggested List of Practical:

1. Setting up Python environment, introduction to libraries like NumPy, Pandas, and scikit-learn.
2. Hands-on data preprocessing using Python libraries.
3. Implementing regression and classification algorithms.
4. Implementing decision trees and ensemble methods.
5. Implementing clustering and dimensionality reduction techniques.
6. Hands-on projects covering real time applications of machine learning.

Textbooks:

1. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", Cambridge University Press.
2. Hastie, Tibshirani, Friedman, "Introduction to Statistical Machine Learning with Applications in R", Springer, 2nd Edition, 2012
3. Peter Harrington, "Machine Learning in Action", DreamTech Press.

Reference Books:

1. Ethem Alpaydin, "Introduction to Machine Learning", PHI 2nd Edition, 2013
2. C. M. Bishop, "Pattern Recognition and Machine Learning

Detailed Syllabus of DA Track – Sem V & VI

Course Name: Advanced Database Management System

Course Code: PEEC02T

NEP Vertical Basket: PC_PEC

Preamble:

Mastering on mastering advanced database systems demands a structured approach. Our comprehensive roadmap covers query processing, advanced data management, distributed databases, big data, NoSQL, enhanced data models, and information retrieval. Each module delves into its domain, blending theory with hands-on tasks. This systematic curriculum ensures learners gain a holistic understanding of modern database systems, ready to navigate complex data landscapes.

Pre-requisites:
EC08 - DBMS

Objective:

1. To impart knowledge related to query processing and query optimization phases of a database management system.
2. To learn advanced techniques for data management and to overview emerging data models like Temporal, Mobile, and Spatial database.
3. To introduce advanced database models like distributed databases.
4. To create awareness of how enterprise can organize and analyse large amounts of data by creating a Data Warehouse.
5. To understand the process of data extraction, transformation and loading. 6 To understand the concept of Big data and NoSQL databases.
6. To learn different IR models and queries in IR Systems

Course Outcomes:
Learner will be able to:

CO1: Measure query costs and design alternate efficient paths for query execution.

CO2: Apply sophisticated access protocols to control access to the database.

CO3: Design distributed databases for improving resource utilization, availability and performance

CO4: To apply the traits of temporal and spatial data models as per the need

CO5: Perform efficient and effective retrieval of information to facilitate the decision making

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Query Processing and Optimization	Overview: Introduction, Query processing in DBMS, Steps of Query Processing, Measures of Query Cost Selection Operation, Sorting, Join Operation, Evaluation of Expressions. Query Optimization Overview, Goals of Query Optimization, Approaches of Query Optimization, Transformations of Relational Expression Estimating Statistics of Expression Results Choice of Evaluation Plans. Self-learning Topics: Solve problems on query Optimization	6
2	Access Control Mechanism	Discretionary Access Control Based on Granting and Revoking Privileges. Mandatory Access Control and Role Based Access Control, Remote Database access protocol. Self-learning Topics: Learn Data Security concepts like Authentication, Authorization and encryption.	6
3	Distributed Databases	Introduction: Distributed Data Processing, Distributed Database System: Architecture, Types, Design Issues. Data Fragmentation, Allocation in distributed databases. Self-learning Topics: Query Optimization in Distributed Databases	6
4	Enhanced Data Models	Active Database Concepts and Triggers, Temporal Database, Spatial Database, Introduction to Deductive Databases Self-learning Topics: Case Study like : "Temporal Dynamics in Information Retrieval: Modelling Temporal Relevance and Query Intent Shifts Over Time"	6
5	Introduction to Information Retrieval	Retrieval Models, Types of Queries in IR Systems, Text Preprocessing Self-learning Topics : Case Study like “Information retrieval evaluation in practice”	6
Total			**30**

Textbooks:

1. Korth, SIberchatz,Sudarshan, :"Database System Concepts", 6th Edition, McGraw – Hill
2. Elmasri and Navathe, "Fundamentals of Database Systems", 6th Edition, PEARSON Education.
3. Theraja Reema, "Data Warehousing", Oxford University Press.
4. Raghu Ramakrishnan and Johannes Gehrke, "Database Management Systems" 3rd Edition - McGraw Hill

References:

1. Paulraj Ponniah, "Data Warehousing: Fundamentals for IT Professionals", Wiley India.
2. Ralph Kimball, Margy Ross, "The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modelling", 3rd Edition. Wiley India.
3. Peter Rob and Carlos Coronel, "Database Systems Design, Implementation and Management", Thomson Learning, 9th Edition

Course Name: Advanced Database Management System Lab

Course Code: PEEC02P

NEP Vertical Basket: PC_PEC

Preamble:
The Advanced Database Laboratory immerses students in leading-edge database technologies and advanced concepts, expanding upon foundational knowledge from prerequisite courses. Through hands-on exploration, students delve into topics including NoSQL databases, distributed data management, query processing and optimization, and advanced SQL techniques. Practical exercises and projects facilitate a deeper understanding of database design, optimization, and administration. Additionally, students gain valuable insights into emerging trends and challenges within the dynamic realm of database management.

Pre-requisites:

EC08 - DBMS

Objective:

- Mastering Conceptual DB Design using EER Model and implementing it using SQL DDL
- Explore advanced SQL concepts
- Gain practical experience in working with distributed databases, temporal data bases, spatial data bases and active databases and proposing a solution using appropriate model(s).
- Learn how to integrate PHP scripts with MySQL databases to create dynamic web applications.
- Develop proficiency in designing, implementing, and optimizing complex database systems for real-world applications and interface a database with front end tools
- Apply best practices in database administration, security, and scalability to ensure robust and efficient database systems.

Course Outcomes:

Learner will be able to:

CO1: Students will be able to design database schemas using EER model techniques and implement them using SQL.

CO2: Students will demonstrate proficiency in writing advanced SQL queries and understand query optimization principles.

CO3: Students will develop skills in accessing and manipulating databases through JDBC in Java programs.

CO4: Students will understand query evaluation plans, indexing strategies, and their impact on database performance.

CO5: Students will implement distributed database solutions, including partitioning strategies, for scalability and performance.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

Suggested list of experiments:

Sr. No.	List of experiments
1	Design EER Model for a real-life scenario and implement it using SQL
2	Understand and compare performance by rewriting queries using indexing
3	Implement the Program to estimate cost of the query for various join operation
4	Build Web Applications with access control features
5	Explore the security and access control features of PostgreSQL (or equivalent system)
6	Implementation of fragmentation in distributed database environment.
7	Implementation of triggers for understanding features of active database
8	Design a temporal and spatial data base schema , map it to tables and solve queries involving temporal and spatial attributes

Textbooks:

1. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", 4th Edition, Pearson/Addision wesley, 2007
2. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, "Database System Concepts", 6th edition, Tata McGraw Hill, 2011

Reference Books:

1. T. Özsu and P. Valduriez, Distributed Database Systems. Prentice Hall, Oct. 2011. [ISBN: 013616736X]
2. NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence" by Martin Fowler and Pramod J. Sadalage

Course Name: Data Warehousing & Mining

Course Code: PEEC06T

NEP Vertical Basket: PC_PEC

Preamble:

In today's data-driven world, organizations rely heavily on data warehousing and data mining techniques to extract meaningful insights from large volumes of data. This course aims to provide learners with a comprehensive understanding of the foundational principles of data warehousing and basic concepts of data mining. Through theoretical exploration, participants will gain insights into the design, implementation, and administration of data warehouses, as well as the fundamental techniques and applications of data mining.

Pre-requisites:

EC22T - Advance Database Management Systems

Course Objectives:

- Understand the fundamental concepts and historical development of data warehousing.
- Gain insights into the design principles and architecture of data warehouses.
- Explore the processes involved in ETL (Extract, Transform, Load) in data warehousing.
- Understand the fundamental concepts and architecture of data lakes as centralized repositories for storing and processing diverse data types.
- Familiarize oneself with basic concepts and techniques of data mining, including preprocessing, model building, and evaluation.
- Explore the various methods and applications of data mining in real-world scenarios.

Course Outcomes:

On successful completion, of course, learner/student will be able to:

CO1: Demonstrate a comprehensive understanding of the fundamental concepts of data warehousing and its architecture.

CO2: Design a data warehouse schema using dimensional modeling techniques and explain the ETL process involved in data warehousing.

CO3: To introduce concepts and fundamentals of data lakes

CO4: Understand data mining principles and perform data preprocessing and Visualization.

CO5: Understand the concept of data mining and identify appropriate data mining algorithms to solve real-world problems.

CO6: Implement basic data mining algorithms such as classification, clustering, and association mining

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to data warehouse and ETL Process	Introduction to Data Warehouse and Data Mart , Data warehouse architecture, Data warehouse vs Data Marts Dimensional modeling, Design of information package, star schema, snowflake schema, fact constellation schema, factless fact tables, aggregate fact tables. OLAP operations ETL process: Basic steps of the ETL process, different extraction methods, transformations, and different loading techniques.	8
2	Introduction to Data Lakes	Definition, key attributes of data lake, challenges, functionalities, architecture, Curating data lakes, Data Lake vs. data warehouse	3
3	Data Exploration and Data Preprocessing	The KDD process, Data mining system architecture, Data Exploration: Types of Attributes, Statistical Description of Data,Data Visualization: box plots, line & bar charts, and scatter plots.Data Preprocessing: Descriptive data, summarization, Cleaning, Integration & transformation, Data reduction.	5
4	Classification	Introduction to data mining techniques, Classification: Decision Tree Induction, Naïve Bayesian Classification. Regression: Simple and multiple	5
5	Clustering	Clustering: Partition based: K-means, Hierarchical Methods (Agglomerative, Divisive).	4

6	Mining frequent patterns and associations	Basic Concepts: Market Basket Analysis, Frequent Itemset, Closed Itemset, and Association Rules; Frequent Itemset. Mining Methods: The Apriori Algorithm: Finding Frequent Itemset Using Candidate Generation, Generating Association Rules from requent Itemset, Improving the Efficiency of Apriori, A pattern growth approach for mining Frequent Itemset, Mining Frequent Itemset using vertical data formats.	5
		Total	**30**

Textbooks:

3. Margy Ross and Ralph Kimball, "The Data Warehouse Toolkit", 3rd edition, Willey
4. Paulraj Ponniah, "Data Warehouse Fundamentals", Wiley-Interscience Publication
5. Bill Inmon, "Data Lake Architecture", 1st edition, Technics Publication
6. Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining Concepts and Techniques", 3rd edition, Elsevier

Reference Books:

1. W. H. Inmon, "Building the Data Warehouse", 3rd edition, Wiley Computer Publishing

Course Name: Data Warehousing & Mining Lab

Course Code: PEEC06P

NEP Vertical Basket: PC_PEC

Preamble:

In today's data-driven world, organizations rely heavily on data warehousing and data mining techniques to extract meaningful insights from large volumes of data. This course aims to provide learners with a comprehensive understanding of the foundational principles of data warehousing and basic concepts of data mining. Through hands-on exploration, learners will gain insights into the design and implementation of data warehouses, as well as the fundamental techniques and applications of data mining.

Pre-requisites:

EC22P – Advance Database Management Systems Lab

Course Objectives:

- Understand and design the concepts of star, snowflake, and galaxy schemas for efficient data organization in data warehouses.
- Understand and execute complex queries and apply OLAP operations effectively.
- Understand various preprocessing and visualization techniques.
- Apply regression techniques and classification algorithms to analyze data, predict outcomes, and gain valuable insights.
- Implement clustering algorithms to effectively group data based on similarities, facilitating improved data organization and analysis.
- Apply association rule mining techniques to identify and analyze patterns and relationships between variables in large datasets.

Course Outcomes:

Learner will be able to:
CO1: Develop and design star, snowflake, and galaxy schemas for data warehouses.
CO2: Execute complex queries and perform Online Analytical Processing (OLAP) operations to analyze data.
CO3: Apply various data preprocessing and visualization techniques to effectively communicate data insights and patterns.
CO4: Implement regression techniques and classification algorithms to analyze data, predict outcomes, and gain valuable insights in practical scenarios.
CO5: Implement clustering algorithms to group data based on similarities.
CO6: Implement association rule mining techniques to identify and analyze patterns and relationships

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall decide her/his assessment methodology based on the course's nature. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested list of experiments:

Sr. No.	List of experiments	Concept
1	Design Information Package, Star Schema & Snowflake Schema	Data Warehouse schema design
2	DW queries & OLAP operations	OLAP
3	Apply different visualization techniques	Data Visualization
4	To implement linear regression (Simple & Multiple) -Python	Regression analysis
5	To implement the ID3 decision tree algorithm – rapid miner and Weka	Classification
6	To implement Naïve Bayes classifier(python)	Classification
8	To implement the K-means clustering algorithm – weka and Rapidminer	Clustering
9	To implement Agglomerative clustering algorithm -python	Clustering
10	To implement the Apriori algorithm – Weka and RapidMiner	Association Analysis

Course Name: Probabilistic Graphical Model

Course Code: PEEC10T

NEP Vertical Basket: PC_PEC

Preamble:

Probabilistic graphical models (PGMs) are a powerful framework that combines probability theory and graph theory to represent and reason about uncertainties in complex systems. They use graphs to encode the conditional dependencies between random variables, facilitating efficient computation of joint distributions and marginal probabilities. PGMs include various models such as Bayesian networks, which utilize directed acyclic graphs, and Markov networks, which employ undirected graphs to represent relationships. These models are widely used in fields like machine learning, artificial intelligence, and bioinformatics for tasks such as prediction, diagnostics, and decision-making under uncertainty.

Pre-requisites:

All Engineering Mathematics & Machine Learning

Course Objectives:

- Understand the principles of probability including random variables, distributions, expectation, and variance, to model and analyze uncertainty in various contexts.
- Understand the fundamental concepts and algorithms of graph theory, enabling the analysis and optimization of networks and relational structures.
- Learn to construct and use Bayesian networks for representing probabilistic dependencies, performing inference, and making data-driven decisions.
- Understand and apply Markov network models to capture and analyze local dependencies in undirected graphs for complex system modeling.
- Gain proficiency in modeling and analyzing sequential and time-series data using Hidden Markov Models.
- Explore practical applications of probabilistic graphical models across machine learning, artificial intelligence, and bioinformatics, developing skills to solve real-world problems.

Course Outcomes:

Learner will be able to:
CO1: Understand the basic concepts of Probability theory and Graph theory.
CO2: Learn and apply Bayesian networks for representing probabilistic dependencies, performing inference, and making data-driven decisions.
CO3: Understand and utilize Markov network models to represent joint distributions and local dependencies, enhancing their analytical skills for complex systems.
CO4: Gain proficiency in modeling and analyzing sequential and time-series data using Hidden Markov Models,
CO5: To make inferences, learning, actions and decisions while applying probabilistic models.
CO6: Represent real world problems using graphical models; design inference algorithms; and learn the structure of the graphical model from data.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	--	2	--

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Probability & Graph Theory	Introduction to Probability Theory: Probability Theory, Basic Concepts in Probability, Probability Axioms and Properties, Conditional Probability and Independence, Discrete Random Variables: Binomial, Poisson, Continuous Random Variables: Uniform, Normal, Continuous Spaces, Expectation, Variance and Covariance. Introduction to Graphs: Graph Definitions and Types, Graph Representation: Adjacency Matrix and List, Subgraphs, Paths and Trails, Cycles and Loop.	4
2	Bayesian Network Model and Inference	Directed Graph Model: Bayesian Network-Structure and Semantics, Exploiting Independence Properties, Naive Bayes Model, Bayesian Network Model, Basic Independencies in Bayesian Networks, Conditional Independence and d-Separation, Bayesian Network Semantics, Graphs and Distributions. Exact inference: Variable Elimination, Conditioning, CPD's and its types, Inference with Structured CPDs.	6
3	Markov Network Model and Inference	Undirected Graph Model: Markov Model-Structure and Components of Markov Networks, Parameter Estimation Techniques, Gibb's distribution, Reduced Markov Network, Markov Network Independencies.	6

		Exact inference variable elimination: Graph Theoretical Analysis for Variable Elimination, Conditioning.	
4	Hidden Markov Model and Inference	Structure of HMM: States, Observations, Probabilities, Template Based Graph Model: HMM- Temporal Models, Template Variables and Template Factors, Directed Probabilistic Models, Undirected Representation, Structural Uncertainty.	6
5	Learning and Taking Actions and Decisions	Learning Graphical Models: Goals of Learning, Density Estimation, Specific Prediction Tasks, Knowledge Discovery. Learning as Optimization: Empirical Risk, over fitting, Generalization, Evaluating Generalization Performance, selecting a Learning Procedure, Goodness of fit, Learning Tasks. Parameter Estimation: Maximum Likelihood Estimation, MLE for Bayesian Networks. Causality: Conditioning and Intervention, Correlation and Causation, Causal Models, Structural Causal Identifiability, Mechanisms and Response Variables, Learning Causal Models. Utilities and Decisions: Maximizing Expected Utility, Utility Elicitation. Structured Decision Problems: Decision Tree.	6
6	Applications	Application of Bayesian Networks: Classification, Forecasting, Decision Making. Application of Markov Models: Cost Effectiveness Analysis, Relational Markov Model and its Applications, Application in Portfolio Optimization. Application of HMM: Speech Recognition, Part of Speech Tagging, Bioinformatics.	2
Total			**30**

Textbooks:

1. Daphne Koller and Nir Friedman, "Probabilistic Graphical Models: Principles and Techniques",
2. Cambridge, MA: The MIT Press, 2009 (ISBN 978-0-262-0139- 2).
3. David Barber, "Bayesian Reasoning and Machine Learning", Cambridge University Press, 1st edition, 2011.
4. Martin Wainwright and Michael Jordan, M., "Graphical Models, Exponential Families, and Variational Inference", 2008.

Reference books:

1. Finn Jensen and Thomas Nielsen, "Bayesian Networks and Decision Graphs (Information Science and Statistics)", 2nd Edition, Springer, 2007.
2. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.

Course Name: Probabilistic Graphical Model Lab

Course Code: PEEC10P

NEP Vertical Basket: PC_PEC

Preamble:

In PGM practical sessions, students will delve into the fundamental concepts and applications of probability theory, graph theory, Bayesian networks, Markov networks, and hidden Markov models. Through hands-on exercises and projects, they will gain proficiency in simulating probabilistic outcomes, implementing graph algorithms for traversal and optimization, constructing Bayesian networks from data, performing inference in Markov networks, and decoding sequences using hidden Markov models. These practical's aim to bridge theoretical understanding with practical skills, equipping students with the tools to analyze real-world data, model complex systems, and make informed decisions in uncertain environments

Pre-requisites:

Skill Based Lab-Python Programming

Course Objectives:

- Implement simulations and analyze real-world data to understand and apply fundamental probabilistic concepts.
- Apply graph algorithms to solve optimization problems and analyze network structures in various applications.
- Construct Bayesian networks & Markov Network models from data and perform probabilistic inference for decision-making under uncertainty.
- Implement sequence analysis algorithms to decode hidden states and apply HMMs in pattern recognition tasks.

Course Outcomes:

Learner will be able:
CO1: To simulate and analyze probabilistic phenomena, applying statistical methods to real-world data. CO2: To apply graph algorithms to solve problems in connectivity, shortest paths, and network flows, demonstrating analytical skills in network analysis.
CO3: Evaluate Bayesian networks from data, performing probabilistic inference and decision analysis in uncertain environments.
CO4: Use factor graphs and inference algorithms to model and analyze complex probabilistic relationships in data.
CO5: Implement algorithms for sequence analysis, decode hidden states using HMMs, and apply them in tasks such as speech recognition and biological sequence analysis.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Practical's:

Sr No.	Title of Practical's
1	Experiment on Probability Theory
2	Experiment on Graph Theory
3	Experiment on Bayesian Network Modelling
4	Experiment on Markov Chain Modeling
5	Experiment on HMM
6	Experiment on Maximum Likelihood Estimation
7	Experiment on Decision Making using Decision Trees
8	Experiment on Learning with Optimization

Detailed Syllabus of IoT Track – Sem V & VI

Course Name: Modern Sensors for Internet of Things

Course Code: PEEC03T

NEP Vertical Basket: PC_PEC

Preamble:

This course introduces students to the fundamental principles and applications of sensors in various engineering fields. It covers different types of sensors, their working mechanisms, and their integration into systems, including IoT, embedded systems, and other fields.

Pre-requisites: Nil

Course Objectives:

- Understand the basic principles and classifications of sensors.
- Learn about various types of sensors and their applications.
- Design and implement sensor systems in practical scenarios.
- Integrate sensors with IoT and embedded systems.
- Explore the use of sensors in biomedical applications

Course Outcomes:

Student will be able to:
CO1: Understand fundamentals of Sensors and their characteristics.
CO2: Use different type sensors in Embedded and IoT applications.
CO3: Apply knowledge of conditioning in the design of data acquisition system.
CO4: Create a small sensor network using knowledge of communication protocols.
CO5: Understand concept of communication protocols.
CO6: Designing small applications using one or more sensor.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module no	Module name	Content	No of Hours
1	Sensors Fundamentals and Characteristics	Sensor Classification, Physical Principles of Sensors- Resistive, capacitive, inductive sensors, Optical, magnetic, and thermal sensors, Sensor Characteristics, Performance and Types, Error Analysis characteristics- Sensitivity, accuracy, precision, range, and resolution. Response time and stability, Applications in various fields and criteria to select sensor	5
2	Types of sensors	Optical Sensors- Photodetectors and phototransistors, Fiber optic sensors, Imaging sensors. Mechanical Sensors- Strain gauges and pressure sensors, Accelerometers and gyroscopes, Ultrasonic sensors. Chemical and Biological Sensors- Electrochemical sensors, gas sensors, humidity and temperature sensors, Biosensors	6
3	Data acquisition and Signal Conditioning	Analog and Digital data acquisition system, Data logger, Amplification, filtering, and Analog-to-Digital conversion, Noise reduction techniques, Calibration methods	5
4	Wireless Sensor Networks	Basics of wireless communication, Network topologies and protocols, Bluetooth, ZigBee, Ultra Wide Band (UWB), Near Field Communication (NF) and RFID, WiFi and IEEE 802.11architecture, applications in IoT.	6
5	IoT Systems Integration and communication protocols	Introduction to IoT, Integrating sensors with microcontrollers (e.g., Arduino, Raspberry Pi), Communication protocols (I2C, SPI, UART),	4
6	Sensor applications	On board automobile sensing system, Home automation and Environment monitoring system, Biomedical sensing system, Radio sensing for industrial applications,	4
Total			**30**

Textbooks:

1. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York.
2. Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland
3. D. Patranabis – Sensor and Transducers (2e) Prentice Hall, New Delhi, 2003
4. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)",1st Edition, VPT, 2014
5. Sensors and Transducers" by Ian R. Sinclair - Comprehensive introduction to various sensors and their applications.

Reference Books:

1. Edited by Qusay F Hasan, Atta ur rehman Khan, Sajid A madani, "Internet of Things Challenges, Advances, and Application", CRC Press
2. Triethy HL - Transducers in Electronic and Mechanical Designs, Mercel Dekker, 2003
3. Gerd Keiser,"Optical Fiber Communications", 2017, 5th edition, McGraw-Hill Science, Delhi. 212

4. John G Webster, Halit Eren, "Measurement, Instrumentation and sensor Handbook", 2014, 2nd edition, CRC Press, Taylor and Fransis Group, New York.
5. Adrian McEwen, "Designing the Internet of Things",Wiley Publishers, 2013, ISBN: 978-1-118-43062-0
6. Nathan Ida, "Sensors, Actuators and their Interfaces: A Multidisciplinary Introduction", Second Edition, IET Control, Robotics and Sensors Series 127, 2020

Course Name: Modern Sensors for Internet of Things Lab

Course Code: PEEC03P

NEP Vertical Basket: PC_PEC

Preamble:

This course introduces students to different types of sensors, their working mechanisms, and their integration into systems. Selection and interfacing of a sensor in the IoT and embedded systems design.

Pre-requisites: Nil

Course Objectives:

- To understand various sensors type and their characteristics.
- To understand different type of sensors and their application.
- To understand communication protocol and their use in sensor network.
- To understand various types communication protocols required in IoT applications and their characteristics.
- To learn to develop small IoT or Embedded system using sensor.

Course Outcomes:

Student will be able to:

CO1: Identify and test the characteristics of various sensors.
CO2: Select most appropriate sensor and design required signal condition for the same.
CO3: Implement communication and wireless communication protocol in IoT application.
CO4: Design and implement small IoT or Embedded system.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Scheme:

Head	ISA	MSE	ESE	Total
Practical	25	-	25	050

Suggested List of Practical:

- Identification of sensor and their important characteristics.
- Testing and Calibration of sensor.
- Identification of Sensitivity, range, resolution, Response time parameters of sensors
- Develop a system to record one of the physical parameter using appropriate sensor
- Develop a system to communicate one or more physical parameters using wireless

communication.

- Develop a system to communicate one or more physical parameters using communication protocol.
- Design and develop a small IoT or system using one or more sensor and a communication procol.

Textbooks:

1. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York.
2. Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland
3. D. Patranabis – Sensor and Transducers (2e) Prentice Hall, New Delhi, 2003
4. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)",1st Edition, VPT, 2014
5. Sensors and Transducers" by Ian R. Sinclair - Comprehensive introduction to various sensors and their applications.

Reference Books:

1. Edited by Qusay F Hasan, Atta ur rehman Khan, Sajid A madani, "Internet of Things Challenges, Advances, and Application", CRC Press
2. Triethy HL - Transducers in Electronic and Mechanical Designs, Mercel Dekker, 2003
3. Gerd Keiser,"Optical Fiber Communications", 2017, 5th edition, McGraw-Hill Science, Delhi. 212
4. John G Webster, Halit Eren, "Measurement, Instrumentation and sensor Handbook", 2014, 2nd edition, CRC Press, Taylor and Fransis Group, New York.
5. Adrian McEwen, "Designing the Internet of Things", Wiley Publishers, 2013, ISBN: 978-1-118-43062-0
6. Nathan Ida, "Sensors, Actuators and their Interfaces: A Multidisciplinary Introduction", Second Edition, IET Control, Robotics and Sensors Series 127, 2020

Course Name: Principles of Internet of Things

Course Code: PEEC07T

NEP Vertical Basket: PC_PEC

Preamble:

The world around us is becoming increasingly interconnected. Internet of Things (IoT), a rapidly evolving field that's transforming the way we live, work, and interact with the world around us. This course will be your deep dive into the foundations of IoT. Students will delve into the language of sensors and actuators, uncover the secrets of communication between devices, and understand the challenges and opportunities that come with a connected world. By the end, students will gain a solid understanding of the fundamental building blocks of IoT and be well-equipped to navigate this exciting and ever-growing field. Students will also be able to build use cases and Mini projects

Pre-requisites:

- C Programming
- Object Oriented Programming
- Microprocessor and Microcontroller

Course Objectives:

- To Understand the core concepts of the Internet of Things (IoT) and its key components & Levels.
- To Explore different Protocols used in IoT Communication
- To Gain a foundational knowledge of common IoT Interfaces.
- To Develop critical thinking skills to analyze proper selection of Boards
- To build practical skills by programming or building a simple IoT project to solidify your understanding**.**

Course Outcomes:

Student will be able to:
CO1: Understand the concept of IoT and its key components of IoT.
CO2: Understand different IoT Communication Protocols.
CO3: Understand different hardware Communication Protocols.
CO4: Select appropriate development boards for Building IOT Applications.
CO5: Develop programs for IoT application.
CO6: Develop creative applications of IoT technology in chosen fields.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of learning	**ISA**	**MSE**	**ESE**	**Total**
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Introduction to Internet of Things	1.1 Definition and characteristics of IoT 1.2 History and evolution of IoT 1.3 Architectural layers of an IoT system (perception, network, application, data management) 1.4 Levels of IoT	5
2	Communication Protocols	2.1 IoT Edge to Cloud protocols: HTTP, REST APIs, WebSocket, MQTT, COAP, Comparison of Protocols.M2M Communication Protocols, 2.2 Bluetooth BR/EDR and Bluetooth low energy. RFID IoT System , RFID IoT Network Architecture, ZigBee IP/ZigBee SE2.0, Wifi(WLAN), 2.3 Message Communication protocols for connected devices Data exchange formats: JSON & XML	5
3	Sensor Interfaces	3.1 Digital Interfaces: UART, Serial Peripheral Interface (SPI), I2C (Inter-Integrated Circuit), Controller Area Network (CAN), Middleware Technologies, 3.2 Communication Protocols and Models. Practical Components Programming with interface in Arduino, MBed and Raspberry Pi	5
4	Hardware Fundamentals	4.1 Introduction to various sensors (temperature, humidity, pressure, motion, etc.) 4.2 Actuators and their types (solenoids, motors, relays) 4.3 Microcontrollers and development boards (e.g., Arduino, Raspberry Pi) 4.4 Interfacing sensors and actuators with microcontrollers 4.5 Introduction to embedded system design principles	5
5	Software Development for IoT	5.1 Introduction to programming languages for IoT (e.g., Python, C++) 5.2 Data acquisition, processing, and visualization techniques 5.3 Introduction to IoT platforms and frameworks Security considerations in IoT applications	5
6	IOT Applications and USE Cases	Case Studies Illustrating IoT Design in Applications like Home Automation, Smart Cities, Environment, Agriculture, Healthcare.	5
Total			**30**

Textbooks:

1. ArshdeepBahga and Vijay Madisetti, “Internet of Things: A Hands-on Approach, Universities Press.
2. Raj Kamal, “Internet of Things: Architecture and Design Principles”, McGraw Hill Education, First edition

Reference Books:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things
2. N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014.

Course Name: Principles of Internet of Things Lab

Course Code: PEEC07T

NEP Vertical Basket: PC_PEC

Preamble:

This lab will describe the market around the Internet of Things (IoT), the technology used to build these kinds of devices, how they communicate, how they store data, and the kinds of distributed systems needed to support them

Pre-requisites:

- C Programming
- Object Oriented Programming
- Microprocessor and Microcontroller

Course Objectives:

- To Understand interfacing of Sensors & actuators
- To identify how IoT differs from traditional data collection systems.
- To explore the interconnection and integration of the physical world and able to design & develop IOT Devices.

Course Outcomes:

Student will be able to:
CO1: Adapt different techniques for data acquisition using various IoT sensors for different applications.
CO2: Demonstrate the working of actuators based on the collected data.
CO3: Use different IoT simulators and correlate working of IoT protocols.
CO4: Select appropriate development board for IoT application.
CO5: Implement IoT protocols like MQTT for communication to realize the revolution of internet in mobile devices, cloud and sensor networks.
CO6: Develop use cases for Different IoT Applications.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Suggested List of Practical's:

1. To study and implement interfacing of different IoT sensors with Raspberry Pi/Arduino/NodeNCU
2. To study and implement interfacing of actuators based on the data collected using IoT sensors. (like led switch ON/OFF, stepper word)Modulation and Demodulation of Binary Frequency Shift Keying.
3. To study and demonstrate use of IoT simulators (like Beviswise) on any real time device (LED/stepper motor)
4. To study MQTT Mosquitto server and write a program on Arduino/Raspberry Pi to publish sensor data to MQTT broker.
5. Interfacing to Wireless Communication Devices like Bluetooth , LoRA
6. Install OS in Raspberry Pi
7. Predictive Maintenance in Industrial Automation Systems
8. Study different hardware Boards used in IoT applications

Mini Projects / Case Study :-
Select any one case study (in a group of 2-3) and perform the experiments 5 to 10. The sample case studies can be as follows:
1. Smart home automation system
2. Healthcare management system
3. Smart traffic management system & so on…
4. Write a program on Raspberry Pi to push and retrieve the data from cloud like thing speak, things board, AWS, Azure etc.

Textbooks / Reference Books

1. Jake VanderPlas, "Python Data Science Handbook", O'Reilly publication, 2016
2. Joakim Verona," Practical DevOps", PACKT publishing, 2016
3. Honbo Zhou," The internet of things in the cloud", CRC press, Taylor and Francis group, 2012
4. Perry Lea," Internet of things for architects", PACKT publishing, 2018

Course Name: Embedded System Design with Tiny Operating System (OS)

Course Code: PEEC11T

NEP Vertical Basket: PC_PEC

Preamble:

Embedded System is used for developing a dedicated task or application. Internet of Things (IoT) is an upcoming technology based on the base of embedded systems. Machine learning (ML) is also an upcoming technology and concepts of ML are used in many applications. This course blends the concepts of embedded systems with machine learning for developing smart and dedicated applications for requirements of IoT. It introduces the fundamental concepts of operating systems and use of operating system in the development of embedded systems.

Pre-requisites:

- C Programming
- Object Oriented Programming
- Microprocessor and microcontroller

Course Objectives:

- To understand the fundamentals of ARM 7 family.
- To understand concepts of embedded systems.
- To understand communication interface for embedded systems.
- To understand working with Real Time Operating Systems (RTOS).
- To understand fundamental concepts of tiny machine learning.
- To use tiny machine learning for embedded systems.

Course Outcomes:

Student will be able to:

CO1: Understand fundamental concepts of advanced 32 bit micro-controllers.

CO2: Demonstrate the fundamental concepts of embedded system design

CO3: Use communication interface for design of embedded system.

CO4: Understand concept of Real Time Operating Systems (RTOS) for embedded system design.

CO5: Understand fundamental concepts of tiny machine learning.

CO6: Use concept of tiny machine learning for design of embedded systems.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	2	2	1

Assessment Guidelines:

Head	ISA	MSE	ESE	Total (Passing @40% of total)
Theory	15	20	40	075

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module no	Module name	Content	No of Hours
1	ARM 7 family and Programming	Introduction, features, basic architecture, Cortex family, register organization with different registers like CPSR	6
2	Introduction to embedded systems	Introduction and different examples/applications, classification of embedded systems, design metrics of an embedded systems, embedded system design life cycle, processor technology for embedded systems, concept of modelling in embedded systems	5
3	Communication Protocols for embedded systems	UART, SPI, I2C, CAN with details like pins, working, timing diagram and common applications, introduction to other communication protocols like zig-bee and Wi-Fi.	6
4	Real Time Operating Systems	Basic concept of operating system, process management with scheduling and related issues, process synchronization with algorithms, concept of threading	6
5	Machine Learning Fundamentals	Concept of machine learning, fundamentals of tiny ML, design and challenges, Building and training machine learning model, Convolutional Neural Networks	4
6	Application Development	Building applications and deployment of model	3
Total			**30**

Textbooks:

1. Embedded System Architecture, Programming & Design (Tata McGraw Hill Publication, Third Edition)- Raj Kamal
2. An Embedded Software Primer- David E. Simon
3. Embedded Real Time Systems Programming- Sriram V. Iyer, Pankaj Gupta
4. MicroC/OS-II, Indian Low price Edition 2002- Jean J. Labrose
5. Embedded Real Time Systems: Concepts, design & Programming (Dreamtech Publication)- K. V. K. K. Prasad

Reference Books:

1. Embedded System Design: A Unified Hardware/Software Introduction (Wiley Publication)- frank Vahid, Tony Givargis
2. ARM System-on-Chip Architecture (Pearson 2005)- Steve Furber
3. Tiny Machine Learning - Pete Warden and Daniel Situnayake
4. Rajib Mall: "Real Time Systems theory and practice", Pearson 2008

Assessment:

1. **ISA (In-Semester-Assessment):** In semester assessment will carry total 15 marks. It will consist of weekly graded assignments based on modules (each carrying 10 marks). The assignments are self-study work and need to be completed by individual students separately. Every student will be submitting four completed assignments. Students are encouraged to develop their own problem statements and devise a proper method / solution. Importance will be given to the concept understanding and applying it to solve the industrial problem using coding.

2. **MSA (Mid-Semester-Assessment):** Mid Semester Assessment will consist of three mid semester internal theory test carrying 20 marks based on completion of minimum modules. This test will be common for all the students. ***Repeat examination will not be conducted.***

3. **ESE (End-Semester-Examination):** End Semester Examination will be conducted for total of 40 marks based on the completion of remaining modules post completion of mid semester examination or an entire syllabus. This test will be common for all the students.

Course Name: Embedded System Design with Tiny Operating System (OS) Lab

Course Code: PEEC11P

NEP Vertical Basket: PC_PEC

Preamble:

Embedded System is a used for developing a dedicated task or application. Internet of Things (IoT) is an upcoming technology based on the base of embedded systems. Machine learning (ML) is also an upcoming technology and concepts of ML are used in many applications. This course enables learner to use concept of tiny machine learning and Real Time Operating System for design of embedded systems.

Pre-requisites:

- C Programming
- Object Oriented Programming
- Microprocessor and microcontroller

Course Objectives:

- To understand the fundamentals of ARM 7 family.
- To understand concepts of embedded systems.
- To understand communication interface for embedded systems.
- To understand working with Real Time Operating Systems (RTOS).
- To understand fundamental concepts of tiny machine learning.
- To use tiny machine learning for embedded systems.

Course Outcomes:

Student will be able to:

CO1: Use concepts of advanced 32 bit micro-controllers.

CO2: Apply the fundamental concepts of embedded system design.

CO3: Use communication interface for design of embedded system.

CO4: Use Real Time Operating Systems (RTOS) for embedded system design.

CO5: Use fundamental concepts of tiny machine learning.

CO6: Apply concept of tiny machine learning for design of embedded systems.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Scheme:

Head	ISA	MSE	ESE	Total
Practical	25	-	25	25

Suggested List of Practical:

All practical will be project based with focus on following application

1. Smart population count system
2. Smart traffic light system
3. Smart temperature monitoring system
4. E notice board
5. E display
6. Smart elevator system

Textbooks:

1. Embedded System Architecture, Programming & Design (Tata McGraw Hill Publication, Third Edition)- Raj Kamal
2. An Embedded Software Primer- David E. Simon
3. Embedded Real Time Systems Programming- Sriram V. Iyer, Pankaj Gupta
4. MicroC/OS-II, Indian Low price Edition 2002- Jean J. Labrose
5. Embedded Real Time Systems: Concepts, design & Programming (Dreamtech Publication)- K. V. K. K. Prasad

Reference Books:

1. Embedded System Design: A Unified Hardware/Software Introduction (Wiley Publication)- frank Vahid, Tony Givargis
2. ARM System-on-Chip Architecture (Pearson 2005)- Steve Furber
3. Tiny Machine Learning - Pete Warden and Daniel Situnayake
4. Rajib Mall: "Real Time Systems theory and practice", Pearson 2008

Assessment: In-Semester-Assessment (25 Marks)

1. ***All the students are required (mandatory) to be present in person during the laboratory conduction session.*** The ISA will consist of awarding marks for the complete, successful and in time submission of minimum 10 dually graded experiments (project based).
2. ***Project prototype to be developed and demonstrated.***
3. ***Graded marks for 10 experiments will be converted to ISA marks of 25. Only one repeat session is allowed to cover up the missed lab session.***
4. Students will be awarded grade / or marks on each experiment based on his / her own contribution, showcasing the knowledge application skills, demonstrating measurement work, developing code / solution to the given problem and peer interaction.
5. ***Student will lose the marks if he or she remains absent for the Laboratory P***

Detailed Syllabus of VLSI Track – Sem V & VI

Course Name: Digital System Design

Course Code: PEEC04T

NEP Vertical Basket: PC_PEC

Preamble:

Digital System design is a study of Programmable Logic Devices, Sequential Circuit Design, Introduction to VERILOG, Levels of Abstraction on VERILOG, and Design of Combinational and Sequential Circuits. This course aims to equip students with the necessary theoretical knowledge and practical skills required in the field of digital logic design and hardware description languages. Through a combination of theoretical lectures, practical demonstrations, and hands-on exercises, students will develop a comprehensive understanding of digital logic design principles and gain proficiency in using hardware description languages for circuit design and simulation.

Pre-requisites:

- Digital Electronics
- Electronic Devices and circuits.
- Basic of VLSI Design

Course Objectives:

- To explore the classification, concepts, and implementation of Programmable Logic Devices (PLDs)
- To learn about the building blocks of synchronous and asynchronous sequential circuits.
- To introduced to VERILOG, a hardware description language widely used in digital design.
- Design various Combinational and Sequential circuits using VERILOG.

Course Outcomes:

CO1: Design hardware that can be implemented on a variety of Programmable Logic Devices.
CO2: Design different sequential circuits using Finite state machine.
CO3: Understand basic entities of Verilog HDL.
CO4: Use various abstraction levels of Verilog HDL for a given application.
CO5: Design the combinational and sequential logic circuits using various constructs in Verilog

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Unit No.	Content	Hrs.
1		**Programmable Logic Devices.**	4
	1.1	Classification of Programmable Logic Devices, Concept and Implementation of PROM, PLA, and PAL. CPLD and FPGA	
	1.2	Block diagram of CPLD, General Structure of FPGA, Introduction to XILINX FPGA family.	
2		**Sequential Circuit design using state machines.**	8
	2.1	Building blocks of Synchronous and Asynchronous sequential circuits. General Model of Synchronous Sequential circuit, Moore, and Mealy Circuits.	
	2.2	Analysis Synchronous and Asynchronous sequential circuits: State Table, State diagram, state equation, state reduction, state assignment and logic realization Design of synchronous sequential circuits using various flip flops.	
3		**Introduction to VERILOG.**	4
	3.1	Lexical Conventions, Methodology: Top Down & Bottom Up Modules, Data types, Arrays, Ports, Variables and Constants, Operator types, Functions and Tasks, Test Bench.	
	3.2	VERILOG Primitives. VERILOG Language formal syntax	
4		**Levels of Abstraction on VERILOG**	6
	4.1	Gate-Level Modelling: Modelling using basic Verilog gate primitives, description of and/or and buff/not type gates, rise, fall and turn-off delays, min, max, and typical delays.	
	4.2	Dataflow Modelling: Continuous assignments, delay specification, expressions, operators, operands, operator types.	
	4.3	Behavioural Modelling: Structured procedures, initial and always, blocking and nonblocking statements, delay, control, generate statement, event control, conditional statements, multiway branching, loops, sequential and parallel block	
5		**Design of Combinational and Sequential Circuits**	8
	5.1	Design of Adders, Multiplexers, Demultiplexers, Encoders and Decoders using VERILOG.	
	5.2	Design of various Flip-Flops, Counters and Shift registers using VERILOG.	
	5.3	Design of ALU, IIR & FIR Filters using VERILOG.	
Total			**30**

Textbooks:

Sr. No	Textbook Titles	Author/s	Publisher	Edition	Module Nos.
1	Fundamentals of Digital Design	M. Senthil Sivakuma	S.Chand	4th Edition 2023	1,2,
2	Verilog HDL	Samir Palnitkar	Pearson Education	2nd Edition 2018	3,4,5

Reference Books:

Sr. No	Textbook Titles	Author/s	Publisher	Edition	Module Nos.
1	Digital Design Principal and Practises.	John F. Wakerly	PHI	4th 2006	1,2,
2	Digital Design with RTL design VHDL and VERILOG	Frank Vahid	Wiley	2011	1,2
3	FPGA Prototyping by VERILOG Examples.	Pong.P.Chu	Wiley	3rd	3,4,5
4	Advanced Digital Design with VERILOG HDL	Michael D. Ciletti.	Pearson	2nd Edition 2018	3,4,5

Course Name: Digital System Design Lab

Course Code: PEEC04P

NEP Vertical Basket: PC_PEC

Preamble:

Digital System design is a study of Programmable Logic Devices, Sequential Circuit Design, Introduction to VERILOG, Levels of Abstraction on VERILOG, and Design of Combinational and Sequential Circuits. This course aims to equip students with the necessary theoretical knowledge and practical skills required in the field of digital logic design and hardware description languages. Through a combination of theoretical lectures, practical demonstrations, and hands-on exercises, students will develop a comprehensive understanding of digital logic design principles and gain proficiency in using hardware description languages for circuit design and simulation.

Pre-requisites:

- Digital Electronics
- Electronic Devices and circuits.
- Basic of VLSI Design

Course Objectives:

- To explore the classification, concepts, and implementation of Programmable Logic Devices (PLDs)
- To learn about the building blocks of synchronous and asynchronous sequential circuits.
- To introduced to VERILOG, a hardware description language widely used in digital design.
- Design various Combinational and Sequential circuits using VERILOG.

Course Outcomes:

CO1: Design hardware that can be implemented on a variety of Programmable Logic Devices.
CO2: Design different sequential circuits using Finite state machine.
CO3: Understand basic entities of Verilog HDL.
CO4: Use various abstraction levels of Verilog HDL for a given application.
CO5: Design the combinational and sequential logic circuits using various constructs in Verilog

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by

a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Experiments:

Practical No.	Module No.	Suggested list of Experiments	Topics to be highlighted	CO Map
1	1,2,3,4,5	Study of simulation and synthesis using tools	Make student aware of different simulation and synthesis tools	1,2,3,4,5
2	1,2,3,4,5	Simulation and implementation of basic Logic Gates using VIVADO and SPRTAN7 FPGA.	Make modules of different logic gates which can be used in the hierarchical description of circuits.	1,2,3,4,5
3	1,2,3,4,5	Simulation and implementation of Half and Full Adder using VIVADO and SPRTAN7 FPGA.	Make modules of different adder which can be used in the hierarchical description of circuits.	1,2,3,4,5
4	1,2,3,4,5	Simulation and implementation of Multiplexers and Demultiplexers using VIVADO and SPRTAN7 FPGA.	Make modules of different mux and demux circuits which can be used in the hierarchical description of circuits.	1,2,3,4,5
5	1,2,3,4,5	Simulation and implementation of Encoder and Decoder using VIVADO and SPRTAN7 FPGA.	Make modules of different encoder and decoders which can be used in the hierarchical description of complex circuits	1,2,3,4,5
6	1,2,3,4,5	Simulation and implementation of Parallel Binary Adder using VIVADO and SPRTAN7 FPGA.	Make modules of different 4 -bit parallel adder which can be used in the hierarchical description of complex circuits. To determine delay in carry generation.	1,2,3,4,5
7	1,2,3,4,5	Simulation and implementation of Carry Look ahead Adder using VIVADO and SPRTAN7 FPGA.	Implementation of carry generation circuit and observe the speed improvement as compared to a ripple carry adder	1,2,3,4,5
8	1,2,3,4,5	Simulation and implementation of various flip-flops using VIVADO and SPRTAN7 FPGA.	Make modules of different various flip flops which can be used in the hierarchical description of complex circuits.	1,2,3,4,5
9	1,2,3,4,5	Simulation and implementation of Counters using VIVADO and SPRTAN7 FPGA.	Implement different counters and compare their performance	1,2,3,4,5
10	1,2,3,4,5	Simulation and implementation Shift Registers using VIVADO and SPRTAN7 FPGA.	Demonstrate PIPO, SISO SIPO and PISO operation	1,2,3,4,5
11	1,2,3,4,5	Simulation and implementation of basic ALU using VIVADO and SPRTAN7 FPGA.	Demonstrate concepts related to ALU design and implementation of various arithmetic and logical functions	1,2,3,4,5

Textbooks:

Sr. No	Textbook Titles	Author/s	Publisher	Edition	Module Nos.
1	Fundamentals of Digital Design	M. Senthil Sivakuma	S.Chand	4th Edition 2023	1,2,
2	Verilog HDL	Samir Palnitkar	Pearson Education	2nd Edition 2018	3,4,5

Reference Books:

Sr. No	Textbook Titles	Author/s	Publisher	Edition	Module Nos.
1	Digital Design Principal and Practises.	John F. Wakerly	PHI	4th 2006	1,2,
2	Digital Design with RTL design VHDL and VERILOG	Frank Vahid	Wiley	2011	1,2
3	FPGA Prototyping by VERILOG Examples.	Pong.P.Chu	Wiley	3rd	3,4,5
4	Advanced Digital Design with VERILOG HDL	Michael D. Ciletti.	Pearson	2nd Edition 2018	3,4,5

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Course Name: Advanced VLSI Design and Technology

Course Code: PEEC08T

NEP Vertical Basket: PC_PEC

Preamble:

This course delineates a comprehensive course on Advanced VLSI Design, focusing on key topics essential for understanding and mastering contemporary semiconductor design methodologies and techniques. Through a structured approach, this course aims to equip students with the knowledge and skills necessary to navigate the complexities of VLSI design, including delay estimation, clocking methodologies, semiconductor manufacturing processes, semiconductor fabrication, and novel device technologies.

Pre-requisite:
- Digital Electronics
- Electronic Devices and Circuits
- Basics of VLSI Design

Course Objectives:

- To provide knowledge of fundamental building blocks of IC fabrication
- To design basic CMOS circuit layouts using Lambda design rules
- To be familiar with various VLSI technologies and novel devices

Course Outcomes:
After successful completion of the course students will be able to:
CO1: Demonstrate a clear understanding of delay estimation using concept of logical effort
CO2: Understand different VLSI Clocking and System Level Physical design issues.
CO3: Explain semiconductor manufacturing and crystal growth techniques.
CO4: Demonstrate a clear understanding of various MOS fabrication processes.
CO5: Study various VLSI technologies and novel devices.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Unit No.	Contents	Hrs.
1		**Delay Estimation**	07
	1.1	RC Delay Models, Elmore Delay Model, Linear Delay Model, interconnect scaling and crosstalk	
	1.2	Logical Effort and Transistor Sizing: Delay in a logic gate, Delay in a Multi-stage Logic Network, Choosing the best number of stages.	
2		**VLSI Clocking and System Level Physical design**	06
	2.1	Clock Generation, Stabilization and Distribution	
	2.2	Clocking Styles: Clocked Cascade, Timing Circle, Clock Skew and Clock Jitter	
	2.3	IO pads and Power Distribution: ESD protection, input circuits, output circuits, simultaneous switching noise, power distribution scheme.	
3		**Semiconductor manufacturing requirements and Crystal growth**	05
	3.1	Semiconductor Manufacturing: Semiconductor technology trend, clean rooms, Wafer cleaning and Gettering	
	3.2	Crystal growth techniques: Czochralski growth, Float Zone growth, Bridgman growth of GaAs, Wafer Preparation and specifications	
4		**Semiconductor Fabrication Processes**	06
	4.1	Oxidation, Deposition, Diffusion, Ion Implantation, Etching, Lithography, Metallization and contacts	
	4.2	CMOS Process Flow: N well, P-well and Twin tub, CMOS Latch Up Design rules: Layout of MOS based circuits (gates and combinational logic), Buried and Butting Contact	
5		**Novel Devices**	06
	5.1	Multi-gate Devices: Various multi-gate device configurations-double gate, triple gate (Fin-FET) and High K-Dielectrics	
	5.2	Nanowire: Concept, VLSI method of fabrication, Nanowire FETs	
	5.3	CNT FET: Introduction to Graphene and CNTFET structure	
		Total	**30**

Textbooks:

Sr. No	Textbook Titles	Author/s	Publisher	Edition	Module Nos.
1	Logical Effort: Designing Fast CMOS Circuits	Ivan Sutherland and Bob Sproull,	The Morgan Kaufmann Series in Computer Architecture and Design	4th	1
2	CMOS VLSI Design: A Circuits and Systems Perspective	Neil H. E. Weste, David Harris and Ayan Banerjee,	Pearson Education	5th	1,2
3	Silicon VLSI Technology	James D. Plummer, Michael D. Deal and Peter B. Griffin,	Pearson	5th	3,4,5
4	VLSI Fabrication Principles‖,	Sorab K. Gandhi	Wiley	5th	3,4,5

Reference Books:

Sr. No	Textbook Titles	Author/s	Publisher	Edition	Module Nos.
1	Digital Integrated Circuits: A Design Perspective	Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic	Pearson Education	2nd	2,3,4,5
2	Introduction to VLSI Circuits and Systems	John P. Uyemura	Wiley India Pvt. Ltd.	Revised 4th Edition	3,4,5
3	CMOS Digital Integrated Circuits Analysis and Design	Sung-Mo Kang and Yusuf Leblebici,	Tata McGraw Hill	Revised 4th Edition	1,2,3,4,5
4	Basics of CMOS Cell Design	Etienne Sicard and Sonia Delmas Bendhia	Tata McGraw Hill	4th	1,2,3,4,5
5	Basic VLSI Design	Douglas A Pucknell, Kamran Eshraghian,	Prentice Hall of India Private Ltd.	3rd	1,2,3,4,5
6	Analysis and Design of Digital Integrated Circuits	David Hodges, Horace Jackson, Resve Saleh.	McGraw-Hill, Inc.	3rd	1,2,3,4,5
7	Advanced Semiconductor Memories: Architectures, Designs, and Applications	Ashok K. Sharma,	Wiley Publication	4th	4
8	Magnetic Memory Technology: Spin-Transfer-Torque MRAM and Beyond	Denny D.Tang, Chi-Feng Pai,	Wiley online Library	2nd	4
9	Resistive Switching: From Fundamentals of Nanoionic Redox Processes to Memristive Device Applications.	Daniele Ielmini, Rainer Waser,	Wiley online Library	3rd	4

Course Name: Advanced VLSI Design and Technology Lab

Course Code: PEEC08P

NEP Vertical Basket: PC_PEC

Preamble:

This course delineates a comprehensive course on Advanced VLSI Design, focusing on key topics essential for understanding and mastering contemporary semiconductor design methodologies and techniques. Through a structured approach, this course aims to equip students with the knowledge and skills necessary to navigate the complexities of VLSI design, including delay estimation, clocking methodologies, semiconductor manufacturing processes, semiconductor fabrication, and novel device technologies.

Pre-requisite:

- Digital Electronics
- Electronic Devices and Circuits
- Basics of VLSI Design

Course Objectives:

- To provide knowledge of fundamental building blocks of IC fabrication
- To design basic CMOS circuit layouts using Lambda design rules
- To be familiar with various VLSI technologies and novel devices

Course Outcomes:

After successful completion of the course students will be able to:
CO1: Demonstrate a clear understanding of delay estimation using concept of logical effort
CO2: Understand different VLSI Clocking and System Level Physical design issues.
CO3: Explain semiconductor manufacturing and crystal growth techniques.
CO4: Demonstrate a clear understanding of various MOS fabrication processes.
CO5: Study various VLSI technologies and novel devices.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised

assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested list of Practical:

Practical No.	Module No.	Suggested list of Experiments	Topics to be highlighted	CO Map
1	1	Comparison of various delay models using CADENCE	Delay estimation using different delay models	CO1
2	1	Calculation of delay offered by FO4 inverter	Concept of estimating the least delay.	CO1
3	3	Simulation of oxidation process using ATCAD Lab of Nanohub.org.in	Oxidation process	CO3
4	3	Simulation of diffusion process using ATCAD Lab of Nanohub.org.in	Diffusion process	CO3
5	4	Design of CMOS inverter layout using Cadence tool	CMOS logic	CO4
6	4	Introduction to CADENCE for VLSI Design. Draw layout for given aspect ratio and implement CMOS inverter, CMOS NAND, NOR logic gates using CADENCE	CMOS logic	CO4
7	4	Implement half and full adder circuits and CADENCE (for layout) and verify functionality of the circuit	CMOS logic	CO4
8	5	Simulation of double gate FinFET using MugFET simulation using ATCAD lab of Nanohub. (nanohub.org.in)	FinFet working	CO5
9	1,2,3,4,5	Simulation of Complete Digital Design Flow in Cadence	Digital Design Flow using Cadence	CO1,2,3,4,5
10	1,2,3,4,5	Simulation of Complete Analog Design Flow in Cadence	Analog Design Flow using Cadence.	CO1,2,3,4,5

Course Name: Analog IC Design

Course Code: PEEC12T

NEP Vertical Basket: PC_PEC

Preamble:

This course focuses on the process of designing analog integrated circuits (ICs) using VLSI techniques. Analog circuits process continuously varying signals, in contrast to digital circuits that manipulate discrete binary values (0s and 1s). Analog VLSI Design involves creating circuits that perform functions such as amplification, filtering, signal conditioning, and analog-to-digital conversion. In Analog VLSI Design, engineers integrate multiple analog functions onto a single chip, often alongside digital components, to create complex systems-on-chip (SoCs) or mixed-signal integrated circuits. Analog VLSI Design poses unique challenges compared to digital design due to the inherent complexities of analog signals and the sensitivity of analog circuits to variations in manufacturing processes, temperature, and voltage. Engineers must carefully consider factors such as noise, distortion, power consumption, and layout parasitic to ensure that the designed circuits meet performance specifications under various operating conditions.

Pre-requisite:

- Digital Electronics
- Electronic Devices and Circuits
- Computer Organization and Architecture
- Basics of VLSI Design

Course Objectives:

- To Gain a deep understanding of fundamental analog circuit topologies, including amplifiers, filters, oscillators, and voltage reference.
- To learn the principles of VLSI design, including transistor-level design, layout techniques, and design verification.
- To explore techniques for optimizing analog circuit performance, such as maximizing bandwidth, achieving low noise, and minimizing power consumption.
- To apply theoretical concepts to real-world design projects, culminating in the design and simulation of complex analog integrated circuits.

Course Outcomes:

After successful completion of the course students will be able to:
CO1: Demonstrate the understanding of various building blocks and their use in design of analog circuits.
CO2: Analyze different single stage amplifiers.
CO3: Understand various types of differential amplifiers.
CO4: Design various OPAMP circuits
CO5: Discuss issues related to Analog Layout and design rules.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Module No.	Unit No.	Contents	Hrs.
1		**Analog building blocks**	06
	1.1	Need for CMOS analog and mixed signal designs, MOS Transistor as sampling switch, active resistances, current source and sinks, current mirror.	
	1.2	Voltage References: Band Gap References, General Considerations, Supply-independent biasing, PTAT & CTAT current generation, Temperature independent references and Constant Gm biasing	
2		**Amplifier Fundamentals**	06
	2.1	Single Stage Amplifiers: Common-source stage (with resistive load, diode connected load, current-source load, triode load, source degeneration), source follower, common-gate stage, cascode stage, folded cascade stage, Frequency response.	
	2.3	Noise: Statistical Characteristics of Noise, Types of Noise, Representation of Noise in circuits, Noise in Single stage amplifiers (CS, CD, CG stages), noise bandwidth, noise figure, noise temperature.	
3		**Differential Amplifiers**	06
	3.1	Differential Amplifiers: Single ended and differential operation, Basic differential pair, large signal and small signal behavior, Qualitative and Quantitative analysis of Common-mode and differential Mode, Frequency response	
	3.2	Differential Pair with MOS Loads, Gilbert Cell, Noise in differential pairs	
4		**MOS Operational Amplifiers**	08
	4.1	Op-amp Design: General Considerations, performance parameters, One-stage op-amps, Two-stage op-amps, Gain Bandwidth (GBW), Gain Boosting, Common-mode feedback, Input range limitations (ICMR), Slew Rate, Power supply rejection, Noise in op-amps.	
	4.2	Stability and Frequency Compensation: General Considerations, Multipole systems, Phase margin, Frequency compensation, compensation of two stage op- amps.	
	4.3	Design of single ended and double ended two stage Op-amps	
5		**Analog Layouts**	04
	5.1	General Layout considerations, Design Rules & antenna Effect	
	5.2	Analog Layout techniques: Multi-finger transistors, symmetry, shallow trench Isolation Issues, well proximity effects, reference distribution, passive devices, interconnect, pads and ESD protection.	
Total			**30**

Textbooks:

Sr. No	Textbook Titles	Author/s	Publisher	Edition	Module Nos.
1	Design of Analog CMOS Integrated Circuits	Behzad Razavi	Tata McGraw Hill	2nd	1,2,3,4,5
2	CMOS Circuit Design, Layout, and Simulation	R. Jacaob Baker, Harry W. Li, David E. Boyce	Wiley	2nd	1,2,3,4,5
3	CMOS Analog Circuit Design	P. E. Allen and D. R. Holberg	Oxford University Press	3rd	1,2,3,4,5
4	Analysis and design of Analog Integrated Circuits	Gray, Meyer, Lewis, Hurst	Wiley	5th	1,2,3,4,5

Reference Books:

Sr. No	Textbook Titles	Author/s	Publisher	Edition	Module Nos.
1	CMOS Circuit Design, Layout and Simulation	Baker Li Boyce	Wiley	3rd	1,2,3,4,5
2	Digital Integrated Circuits: A Design Perspective	Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic	Pearson Education	2nd	2,3,4,5
3	Introduction to VLSI Circuits and Systems	John P. Uyemura	Wiley India Pvt. Ltd.	Revised 4th Edition	3,4,5
4	CMOS Digital Integrated Circuits Analysis and Design	Sung-Mo Kang and Yusuf Leblebici,	Tata McGraw Hill	Revised 4th Edition	1,2,3,4,5
5	Basics of CMOS Cell Design	Etienne Sicard and Sonia Delmas Bendhia	Tata McGraw Hill	4th	1,2,3,4,5
6	CMOS VLSI Design: A Circuits and Systems Perspective	Neil H. E. Weste, David Harris and Ayan Banerjee,	Pearson Education	5th	1,2,3,4,5
7	Analysis and Design of Digital Integrated Circuits	David Hodges, Horace Jackson, Resve Saleh.	McGraw-Hill, Inc.	3rd	1,2,3,4,5
8	Basic VLSI Design	Douglas A Pucknell, Kamran Eshraghian,	Prentice Hall of India Private Ltd.	3rd	1,2,3,4,5

Course Name: Analog IC Design Lab

Course Code: PEEC12P

NEP Vertical Basket: PC_PEC

Preamble:

This course focuses on the process of designing analog integrated circuits (ICs) using VLSI techniques. Analog circuits process continuously varying signals, in contrast to digital circuits that manipulate discrete binary values (0s and 1s). Analog VLSI Design involves creating circuits that perform functions such as amplification, filtering, signal conditioning, and analog-to-digital conversion. In Analog VLSI Design, engineers integrate multiple analog functions onto a single chip, often alongside digital components, to create complex systems-on-chip (SoCs) or mixed-signal integrated circuits. Analog VLSI Design poses unique challenges compared to digital design due to the inherent complexities of analog signals and the sensitivity of analog circuits to variations in manufacturing processes, temperature, and voltage. Engineers must carefully consider factors such as noise, distortion, power consumption, and layout parasitic to ensure that the designed circuits meet performance specifications under various operating conditions.

Pre-requisite:

- Digital Electronics
- Electronic Devices and Circuits
- Computer Organization and Architecture
- Basics of VLSI Design

Course Objectives:

- To Gain a deep understanding of fundamental analog circuit topologies, including amplifiers, filters, oscillators, and voltage reference.
- To learn the principles of VLSI design, including transistor-level design, layout techniques, and design verification.
- To explore techniques for optimizing analog circuit performance, such as maximizing bandwidth, achieving low noise, and minimizing power consumption.
- To apply theoretical concepts to real-world design projects, culminating in the design and simulation of complex analog integrated circuits.

Course Outcomes:

After successful completion of the course students will be able to:
CO1: Demonstrate the understanding of various building blocks and their use in design of analog circuits.
CO2: Analyze different single stage amplifiers.
CO3: Understand various types of differential amplifiers.
CO4: Design various OPAMP circuits
CO5: Discuss issues related to Analog Layout and design rules.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested list of Practical:

Practical No.	Module No.	Suggested list of Experiments	Topics to be highlighted	CO Map
1	1	Analysis of MOSFETs for analog performance	Effect of Body Bias and Channel Length Modulation	CO1
2	1	Design and simulate various types of current mirror circuits	Design of Current Mirrors and techniques to mitigate the effect of channel length modulation	CO1
3	2	Design and simulate various common source amplifier circuits	Compare various types of common source amplifier	CO2
4	2	Design and simulate various types of Common Drain amplifiers	Compare various types of common drain amplifier	CO2
5	2	Design and simulate various types of Common Gate amplifiers	Compare various types of common gate amplifier	CO2
6	3	Design and simulate differential amplifier	Compare various types of differential amplifier	CO3
7	4	Design and simulate operational transconductance amplifier	Compare various topologies of OPAMPS	CO4
8	5	Generate layout for the simple and cascode current mirror	Layout Design Issues while designing cascode amplifier	CO5
9	5	Generate layout for common source amplifier	Layout Design Issues while designing common source amplifier	CO5
10	5	Generate layout for the differential amplifier	Layout Design Issues while designing differential amplifier	CO5
11	1,2,3,4,5	Simulation of Complete Digital Design Flow in Cadence	Digital Design Flow using Cadence	CO1,2,3,4,5,6
12	1,2,3,4,5	Simulation of Complete Analog Design Flow in Cadence	Analog Design Flow using Cadence.	CO1,2,3,4,5,6

Textbooks:

Sr. No	Textbook Titles	Author/s	Publisher	Edition	Module Nos.
1	Design of Analog CMOS Integrated Circuits	Behzad Razavi	Tata McGraw Hill	2nd	1,2,3,4,5
2	CMOS Circuit Design, Layout, and Simulation	R. Jacaob Baker, Harry W. Li, David E. Boyce	Wiley	2nd	1,2,3,4,5
3	CMOS Analog Circuit Design	P. E. Allen and D. R. Holberg	Oxford University Press	3rd	1,2,3,4,5
4	Analysis and design of Analog Integrated Circuits	Gray, Meyer, Lewis, Hurst	Wiley	5th	1,2,3,4,5

Reference Books:

Sr. No	Textbook Titles	Author/s	Publisher	Edition	Module Nos.
1	CMOS Circuit Design, Layout and Simulation	Baker Li Boyce	Wiley	3rd	1,2,3,4,5
2	Digital Integrated Circuits: A Design Perspective	Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic	Pearson Education	2nd	2,3,4,5
3	Introduction to VLSI Circuits and Systems	John P. Uyemura	Wiley India Pvt. Ltd.	Revised 4th Edition	3,4,5
4	CMOS Digital Integrated Circuits Analysis and Design	Sung-Mo Kang and Yusuf Leblebici,	Tata McGraw Hill	Revised 4th Edition	1,2,3,4,5
5	CMOS VLSI Design: A Circuits and Systems Perspective	Neil H. E. Weste, David Harris and Ayan Banerjee,	Pearson Education	5th	1,2,3,4,5
6	Analysis and Design of Digital Integrated Circuits	David Hodges, Horace Jackson, Resve Saleh.	McGraw-Hill, Inc.	3rd	1,2,3,4,5
8	Basic VLSI Design	Douglas A Pucknell, Kamran Eshraghian,	Prentice Hall of India Private Ltd.	3rd	1,2,3,4,5

Course Name: Industry Internship 1

Course Code: OJT01

NEP Vertical Basket: ELC

Preamble:

The Industry Internship aims to bridge the gap between academic learning and industry practices by exposing students to real-time industrial environments. This experience enables them to understand professional expectations, analyze real-world problems, and apply domain knowledge effectively. The internship enhances technical competency, teamwork, communication, ethical responsibility, and problem-solving skills — all essential graduate attributes for future professionals.

Pre-requisites:
NIL

Course Objectives:

Student will be able to:

To expose students to the real-time functioning, tools, and processes used in industry.
To develop the ability to identify industry-based technical or managerial problems.
To formulate structured problem statements and apply academic knowledge for solutions.
To encourage professional ethics, teamwork, and awareness of societal, safety, and environmental aspects.
To develop skills in effective communication, documentation, and project presentation.

Course Outcomes:

Student will be able to:

CO1: Analyze and understand industrial workflows, technologies, and tools through direct exposure.
CO2: Identify and define real-time technical or managerial problems encountered in the industry.
CO3: Propose and/or assist in implementing practical or technical solutions in the industrial context.
CO4: Demonstrate ethical behavior, professional responsibility, and awareness of sustainability and safety.
CO5: Communicate project progress effectively through reports, presentations, and team interaction.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	150	-	5

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	75	-	75	150

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus of Multidisciplinary Minor Courses

Course Name: Skill and Competency Development 1

Course Code: MDM01

NEP Vertical _Basket: MDC_MDM

Category: MC-MDM

Preamble:

The Professional Competence course is designed to develop industry-ready skills by strengthening problem-solving ability, analytical thinking, quantitative aptitude, and effective communication. The course emphasizes logical reasoning, structured coding practices, numerical accuracy, and verbal proficiency required for campus placements and professional environments. By integrating technical foundations with aptitude and communication skills, the course prepares students to perform confidently in online assessments, technical interviews, and workplace scenarios.

Course Objectives:

- Develop strong logical thinking and problem-solving skills required for technical and aptitude assessments.
- Enhance coding proficiency through structured approaches to data structures and algorithmic thinking.
- Build numerical ability and analytical accuracy for quantitative aptitude and data interpretation problems.
- Strengthen reasoning skills including analytical, abstract, and decision-making capabilities.
- Improve verbal ability, reading comprehension, and professional communication skills.
- Prepare students to perform confidently in placement tests, technical interviews, and professional workplace situations.

Pre-requisite required: VSEC01 (Structured Programming), VSEC02 (Object Oriented Programming), VSEC04 (Python Programming)**,** PEBM01 (Integrated Data Management)

Course Outcomes:

Learner will be able to:
CO1: Apply logical and algorithmic thinking to solve programming and data-structure–based problems efficiently.
CO2: Analyze and solve quantitative aptitude and data interpretation problems with speed and accuracy.
CO3: Demonstrate strong reasoning skills while handling analytical, abstract, and decision-making scenarios.
CO4: Interpret problem statements clearly and design structured solutions for real-world and assessment-based problems.
CO5: Use appropriate grammar, vocabulary, and verbal reasoning skills for effective professional communication.
CO6: Perform confidently in online assessments, technical interviews, and other campus recruitment processes.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	50	-	-	050

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Arrays & Basic Patterns, Strings, HashMap.	Array traversal, searching and sorting logic, frequency counting, prefix sum ideas, and pattern-based problem solving using loops. String manipulation involving character processing, palindrome and anagram logic, substring handling, and text-based problem solving. Key–value based data handling using HashMap for efficient frequency tracking, duplicate detection, and optimized lookup operations.	4
2	Two Pointers & Sliding Window, Stack, Monotonic Stack & Queue	Optimized array and string problem solving using left–right pointer techniques and fixed or variable window logic. Stack-based problem solving using LIFO principles for expression handling and element comparison. Ordered stack and queue techniques for range-based problems, window maximum/minimum calculations, and sequential data processing.	4
3	Linked List & Recursion / Backtracking, Trees & Graphs	Node-based data representation with sequential access, insertion, deletion, and traversal operations. Recursive problem decomposition with clear base and recursive conditions, along with systematic backtracking for solution exploration. Hierarchical and network data representation using trees and graphs with traversal and search logic.	4
4	Dynamic Programming	Problem decomposition into overlapping subproblems with result reuse. Logical transition formulation, state definition, and stepwise solution building using memoization and tabulation for improved efficiency.	2
5	Number Systems and Arithmetic, Algebra and Equations, Geometry and	Numerical reasoning involving divisibility, percentages, ratios, averages, equations, and geometric calculations. Logical interpretation of numerical data from tables, charts, and graphs with emphasis on accuracy and time-bound problem solving.	6

	Mensuration, Data Interpretation(DI)		
6	Analytical andCritical Reasoning, Abstract, Visual C Diagrammatic Reasoning (New), Decision Making and Problem Solving	Logical pattern identification, sequential reasoning, relational analysis, and visual interpretation. Structured thinking through case-based scenarios, prioritization tasks, and decision-based problem evaluation.	6
7	Grammar and Usage, Reading Comprehension, Vocabulary and Word Skills, Verbal Reasoning and Communication	Sentence structure, grammatical accuracy, contextual word usage, and comprehension of written passages. Logical interpretation of verbal information, clarity in expression, and professional communication skills for interviews and workplace interactions.	4
Total			**30**

Textbooks:

1. Reema Thereja," Data Structures using C", 2nd edition, Oxford Press, 2014.
2. Aaron M Tenenbaum, Yedidyah Langsam, Moshe J Augenstein, "Data Structures Using C", First Edition, Pearson Publication, 2019.
3. R.S. Aggarwal, *"Quantitative Aptitude for Competitive Examinations"*, Revised Edition, S. Chand Publishing, 2018.
4. Norman Lewis, *"Word Power Made Easy"*, Revised Edition, Goyal Publishers, 2014.

Reference Books:

1. Richard F. Gilberg and Behrouz A. Forouzan, "Data Structures: A Pseudocode Approach with C", 2ndEdition, CENGAGE Learning, 2004.
2. P.S. Deshpande, O.G. Kakde, "C and Data Structures", First Edition, Dreamtech Press, 2003.
3. Balagurusamy, "Data Structure Using C", First Edition, Tata McGraw-Hill Education India, 2013.
4. Arun Sharma, *"How to Prepare for Quantitative Aptitude for the CAT"*, 9th Edition, McGraw Hill Education, 2018.
5. S.P. Bakshi, *"Objective General English"*, 4th Edition, Arihant Publications, 2017.

Related/ Equivalent MOOC and Associated Certification:

1. Introduction to Algorithms (MIT 6.006)
    - Platform: MIT OpenCourseWare (OCW)
    - Link: https://ocw.mit.edu/courses/6-006-introduction-to-algorithms-spring-2020/
2. Introduction to Data Structures and Algorithms
    - Platform: NPTEL (National Programme on Technology Enhanced Learning)
    - Link: https://nptel.ac.in/courses/106102064
3. Data Structures by University of California, San Diego
    - Platform: Coursera
    - Link: https://www.coursera.org/learn/data-structures
4. Foundations of Data Structures and Algorithms Specialization
    - Platform: Coursera

- Link: https://www.coursera.org/specializations/boulder-data-structures-algorithms

5. NPTEL, *"Developing Soft Skills and Personality"*, SWAYAM–NPTEL, IIT Kanpur, with NPTEL Certification.
6. Coursera, *"Improving Communication Skills"*, University of Pennsylvania, with Coursera Certification.
7. LinkedIn Learning, *"Learning Personal Effectiveness"*, LinkedIn Learning Platform, with LinkedIn Certification.

Course Name: Algorithms and Data Structures in Bioinformatics

Course Code: MDMBI02

NEP Vertical _Basket: MDC_MDM

Preamble:

This course is designed with the objective of equipping students with a robust understanding of the integration between biology and computational science, key bioinformatics concepts, methodologies, and applications. Through a combination of theoretical knowledge and practical applications, students will develop a holistic understanding of how various data structures and algorithms can enhance the comprehension of biological processes. It also emphasizes on real-world biological questions and research challenges, empowering them to make meaningful contributions to the rapidly evolving field of bioinformatics

Course Objectives:

- To enable learners to understand the basic data structures for Bioinformatics.
- Build foundational understanding of various algorithms

Pre-requisites:

Introduction to Bioinformatics (MDMBI01)

Course Outcome:

The students will be able to:

CO1: Apply fundamental data structures and algorithms (arrays, trees, graphs, hashing, etc.) to solve computational problems in bioinformatics.

CO2: Analyze and implement sequence alignment algorithms for comparing DNA, RNA, and protein sequences, including global, local, and heuristic approaches.

CO3: Construct and interpret phylogenetic trees using distance-based and character-based algorithms for evolutionary analysis.
CO4: Use algorithmic and statistical models, such as HMMs and motif-finding tools, to predict genes and regulatory elements in genomic sequences.
CO5: Design and evaluate scalable bioinformatics workflows and pipelines using big data technologies and cloud platforms for handling large-scale genomic datasets.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	1(Tutorial)	3	1

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Theory	45	30	50	125

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Module Contents	No. of Hours
01	Review of Data Structures and Algorithms	Arrays, strings, stacks, queues, Graphs and trees: DFS/BFS with examples from biological data, Suffix trees, suffix arrays, tries, Hashing techniques for genome indexing	8
02	Sequence Alignment Algorithms	Needleman-Wunsch algorithm (global alignment) Smith-Waterman algorithm (local alignment) Space optimization (Hirschberg's algorithm) Heuristic alignment methods (BLAST internals) Complexity analysis of sequence alignment algorithms Self-Learning Topics: Recent advances in sequence alignment techniques	10
03	Phylogenetic Tree Construction	Multiple Sequence Alignment (MSA) pre-processing Distance-based methods: UPGMA, Neighbor-Joining Character-based methods: Maximum Parsimony, Maximum Likelihood,Tree visualization tools: MEGA, iTOL Self-Learning Topics: Bayesian approaches in phylogenetics	10
04	Gene Prediction and Motif Finding	Regulatory elements in genomes Basics of Hidden Markov Models (HMMs) Motif discovery tools (MEME, FIMO) Promoter and enhancer identification Use of regular expressions in motif searches Self-Learning Topics: Deep learning methods for gene prediction	10
05	Big Data in Bioinformatics	Challenges of large-scale genomic and multi-omics data, Hadoop and Spark frameworks for bioinformatics, Bioinformatics pipelines: Snakemake, Nextflow,Cloud platforms for genomics: AWS, Google Genomics, Case studies: 1000 Genomes Project, Cancer Genome Atlas Self-Learning Topics: Emerging big data technologies in bioinformatics	07
Total			**45**

Reference Books / Articles

1. Bioinformatics: Sequence and Genome Analysis by Mount D., Cold Spring Harbor Laboratory Press, New York. 2004

2. Bioinformatics- a Practical Guide to the Analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellellette, B.F., Wiley India Pvt Ltd. 2009
3. Introduction to bioinformatics by Teresa K. Attwood, David J. Parry-Smith. Pearson Education. 1999

Course Name: Startup Planning and Development

Course Code: MDMIE02

NEP Vertical_Basket: MDC_MDM

Preamble:
The Startup Planning and Development course is designed to equip aspiring entrepreneurs, innovators, and business leaders with the foundational knowledge and practical skills required to conceive, launch, and scale successful startup ventures.

Pre-requisites: NIL

Course Objectives:

- To develop skills for building, validating, and planning a new venture.
- To understand basic startup finance, legalities, and market strategy.
- To enable students to create business plans and investor pitches.

Course Outcomes:

Student will be able to:

CO1: Design MVPs and apply lean startup methods
CO2: Conduct market and competitor analysis.
CO3: Prepare financial models and pitch decks.
CO4: Understand legal frameworks and intellectual property.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	1(Tutorial)	3	1

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Theory	45	30	50	125

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Lean Startup Methodology	• MVP (Minimum Viable Product) • Pivoting and iteration • Build-Measure-Learn loop	8
2	Market Research and Strategy	• TAM-SAM-SOM analysis • Competitive analysis • Go-to-market strategy	8
3	Startup Finance	• Basics of financial modelling • Unit economics, pricing, and revenue models • Funding sources: bootstrapping, angels, VCs, crowdfunding	10
4	Legal & Regulatory Aspects	• Company formation: types and registration • IPR basics: patents, trademarks, copyrights • Compliance and taxation	6
5	Business Plan Development	• Writing an effective business plan • Pitch deck essentials	7
		Total	**45**

Tutorials (1 Credit):

- Building a mock startup pitch deck
- Simulated investor pitch
- Budgeting and forecasting exercises

Textbooks:

1. Peter Thiel ,Zero to One: Notes on startups, or how to build the future, Crown Business 2014
2. E,ric Ries The Lean Startup, Crown Business 2011
3. Brad Feld ,Venture Deals, Wiley Publications

Course Name: Financial Basics for Engineers and Technopreneurs

Course Code: MDMBD02

NEP Vertical _Basket: MDC_MDM

Preamble:
The objective of this course is to equip students with basic financial skills needed to evaluate and manage technical projects or business ventures. It covers the principles of cost analysis, budgeting, financial statements, and introduction to funding models.

Pre-requisites:
Introduction to Business Development and Marketing Principles

Course Objectives:

- Learn basic financial terminology and concepts.
- Understand components of a budget and perform break-even analysis.
- Analyse financial viability of a project or startup.
- Gain exposure to funding options.

Course Outcomes:

Student will be able to:

CO1: Interpret and analyze basic financial statements (P&L, balance sheet).
CO2: Prepare a project cost sheet and conduct break-even analysis.
CO3: Explain sources of capital and funding stages for startups.
CO4: Apply budgeting techniques to engineering project proposals

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	1(Tutorial)	3	1(Tutorial)

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Theory	45	30	50	125

The assessment guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Introduction to Finance	Financial definitions, roles in business, overview of income, expenses, assets, liabilities, cash flows.	8
2	Costing and Budgeting	Types of costs (fixed/variable), project budgeting, break-even analysis, basic forecasting.	8
3	Financial Statements	Structure and interpretation of P&L, balance sheet, cash flow statements.	10
4	Time Value of Money	Simple vs compound interest, Net Present Value (NPV), Internal Rate of Return (IRR) concepts.	6
5	Funding Sources	Equity, debt, bootstrapping, angel investment, venture capital, crowdfunding.	7
6	Financial Decision Making	Financial ratios (ROI, ROE), pricing basics, cost-benefit analysis, breakeven models.	6
Total			**45**

Textbooks:

1. Finance for Non-Finance Managers, by: V.G. Narayanan, Publisher: Cengage India, ISBN: 9789353501786
2. Finance for Non-Financial Managers by Gene Siciliano, McGraw Hill, Second Edition, (pdf available online)

Reference Books:

1. Introduction to Finance - Yale Online Course
2. Investopedia - Financial Statements Guide

Course Name: Machine Vision and Robotic Perception

Course Code: MDMRB02

NEP Vertical _Basket: MDC_MDM

Preamble:

This course introduces the fundamentals of computer vision and perceptual systems in robotics. It focuses on enabling robots to sense, interpret, and act upon their environment using visual inputs. Students will explore feature detection, image processing, 3D vision, and sensor fusion techniques. Hands-on activities and simulations bridge theory with real-world robotic perception applications.

Course Objectives:

- To introduce fundamental concepts in machine vision and perception relevant to autonomous robots.
- To equip students with techniques for image processing, object detection, and feature extraction.
- To develop the ability to integrate vision systems into robotic control and decision-making.

Pre-requisites:

Fundamentals of Robotics and Control (BMMDM1T)

Course Outcome:

The students will be able to:

CO1: Explain the principles of image formation and the role of cameras in robotic vision systems.
CO2: Apply basic image processing techniques for feature extraction and noise reduction.
CO3: Detect and match key visual features for use in localization and object recognition.
CO4: Analyze depth and motion using stereo vision and 3D reconstruction techniques.
CO5: Implement object detection and scene understanding in robotic applications.
CO6: Integrate visual data with other sensor modalities for robust robotic perception.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
3	2	3	1

Assessment guidelines:

Head of Learning	**ISA**	**MSE**	**ESE**	**Total**
Theory+ Tutorial	45	30	50	125

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Module Contents	No. of Hours
01	Introduction to Machine Vision	Role of vision in robotics, camera models, perspective projection, image formation, lens distortions	06
02	Image Processing Basics	Grayscale and color models, filtering, edge detection, noise reduction, histogram equalization	08
03	Feature Extraction and Matching	Interest point detection (Harris, FAST), descriptors (SIFT, SURF, ORB), template matching, homographies	07
04	3D Vision and Depth Estimation	Stereo vision, structure from motion, depth cameras, triangulation, visual odometry	08
05	Object Detection and Scene Understanding	Image segmentation, object classification (traditional and CNN-based), scene interpretation, semantic mapping	08
06	Sensor Fusion and Perception Systems	Integration of vision with other sensors (IMU, LIDAR), Kalman and particle filters, SLAM fundamentals, case studies	08
Total			**45**

Suggested List of Value-Added Home Assignments:

1. Design a vision-based system that can detect traffic violations like red-light running or illegal turns using video footage.
2. Use a stereo camera or simulated stereo images to generate a 3D point cloud and reconstruct a small indoor environment.
3. Create a system that inspects manufactured parts (e.g., PCB boards, bottles, machined components) and flags defects or anomalies using image processing.
4. Develop a mobile robot that can autonomously locate and scan barcodes or QR codes placed in a room to log inventory data.
5. Implement a system that uses AprilTags or ArUco markers to help a robot localize itself within an indoor environment.
6. Build a system that allows a robot to respond to hand gestures (like stop, go, turn) using a webcam and gesture recognition model.

Recommended Online Courses:

1. Computer Vision Specialization (by University of Buffalo) https://www.coursera.org/specializations/computer-vision
2. Computer Vision, https://www.udacity.com/course/computer-vision-nanodegree--nd891
3. OpenCVBootcamp,https://opencv.org/university/free-opencv-course/?utm_source=google&utm_medium=cpc&utm_campaign=WW_tut_OBC&utm_term=best%20opencv%20tutorial&gad_source=1&gad_campaignid=21004628838&gbraid=0AAAAACbv-

xhUM70mKirK31LiktTRipo8G&gclid=Cj0KCQjw9O_BBhCUARIsAHQMjS7VA3JEdz8KONvGanFNC7KAqSt2HModiDtp5hB_PJKX_oKTK80pNxQaAlcVEALw_wcB

Reference Books / Articles

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 1st Edition, 2011.
2. Peter Corke, Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer, Second Edition, 2017.
3. Adrian Kaehler and Gary Bradski, Learning OpenCV 4: Computer Vision with Python and OpenCV Library, O'Reilly Media, 1st Edition, 2019.
4. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Pearson Education, Fourth Edition, 2018.
5. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Cambridge University Press, Second Edition, 2004.
6. Sudeep Sarkar, Computer Vision: A First Course, Cambridge University Press, First Edition, 2022