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 & Telecommunication Engineering

with Multidisciplinary Minor

Third Year Scheme and Syllabus (R-2023)

(As per NEP 2000, with effect from the Academic Year 2025-26)

Preamble

The National Education Policy (NEP) framework aims to break the mould from teacher centric to student centric educational practices. It empowers the students with flexibility in terms of choosing courses across different faculties and mode 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 life long 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 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 course 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 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. aims 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 student capable of working on industry relevant problems.

Chairman, Board of Studies
Department of Electronics & Telecommunication Engineering
Vidyalankar Institute of Technology

Chairman, Academic Council
Vidyalankar Institute of Technology

Course Structure and Assessment Guidelines

for

T. Y. Bachelor of Technology

in

Electronics and Telecommunication Engineering

with Multidisciplinary Minor

Third Year B. Tech. Electronics & Telecommunication Engineering **Preferred Semester: V**

Course Structure and Assessment Guidelines

	Course		Head of Learning	Credits	Assessment guidelines (Marks)			Total marks (Passing@40 % of total marks)
NEP-Verticals	**Code**	**Name**			**ISA**	**MSE**	**ESE**	
PC_PCC	PCET18T	Basic VLSI Design	Theory	2	15	20	40	075
	PCET18P	Basic VLSI Design Lab	Practical	1	25	-	25	050
	PCET107T	Computer Network	Theory	2	15	20	40	075
	PCET107P	Computer Network Lab	Practical	1	25	-	25	050
	PCET10T	Digital Signal Processing	Theory	2	15	20	40	075
	PCET10P	Digital Signal Processing Lab	Practical	1	25	-	25	050
	PCET103T	Electromagnetics and Antenna	Theory	2	15	20	40	075
	PCET103P	Electromagnetics and Antenna Lab	Practical	1	25	-	25	050
PC_PEC	PEETXXT	Programme Elective-1	Theory	2	15	20	40	075
	PEETXXP	Programme Elective-1 Lab	Practical	1	25	-	25	050
MDM	MDMBDXX*	As per MDM course list[##]	As per course	4	45	30	50	125
Total Credits				**19**				
Credits completed in previous inter semester break course that will appear in this semester marksheet								
OEC	OEC01[$]	Collaborative Inter-Institute Studies (Credit Transfer)	Theory	4	125	-	-	125

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

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.

[$] **For** OEC01- Internship Collaborative Inter-Institute Studies (Credit Transfer)): Internship 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).

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

Important Note 1: Learners are required to go through the Appendix-A carefully before selecting the programme elective courses. Detailed guidelines regarding professional elective courses, specialization tracks and courses relevant to each track are given in Appendix-A. We have total four track. The learners can choose one track from tracks offered by department.

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Programme Elective-1 courses:

Course Code	Course Name	Specialization Track Name #
PEET20T	Modelling and Analysis of Communication System	Communication Engineering
PEET20P	Modelling and Analysis of Communication System Lab	
PEET26T	Database Management System	Data Analytics and Machine Learning
PEET26P	Database Management System Lab	
PEET32T	Modern Sensors for Internet of Thing	Internet of Things
PEET32P	Modern Sensors for Internet of Thing Lab	
PEEC38T	Digital System Design	Very Large Scale Integration
PEEC38P	Digital System Design Lab	

For details of Specialization Certificate, refer Appendix - A

Multidisciplinary Minor (MDM)

Sr. No.	Title of MDM	Course Code	Course Name	Assessment guidelines (Marks)			Credits	Total marks (Passing @40% of total marks
				ISA	MSE	ESE		
1	-	MDM01	Seminar	25	-	50	2	75
2	Bioinformatics	MDMBI01	Introduction to Bioinformatics	45	30	50	4	125
		MDMBI02	Algorithms and Data Structures in Bioinformatics	45	30	50	4	125
		MDMBI03	Machine Learning Applications in Bioinformatics	45	30	50	4	125
3	Innovation, Entrepreneurship and Venture Development	MDMIE01	Foundations of Innovation and Entrepreneurship	45	30	50	4	125
		MDMIE02	Startup Planning and Development	45	30	50	4	125
		4MDMIE03	Innovation Management and Scaling Startups	45	30	50	4	125
4	Business Development, Marketing and Finance	MDMBD01	Introduction to Business Development and Marketing Principles	45	30	50	4	125
		MDMBD02	nancial Basics for Engineers and Technopreneurs	45	30	50	4	125
		MDMBD03	ategic Marketing and Business Planning	45	30	50	4	125
5	Robotics	MDMRB01	Fundamentals of Robotics and Control	45	30	50	4	125
		MDMRB02	chine Vision and Robotic Perception	45	30	50	4	125
		MDMRB03	ntelligent Mobile Robotics	45	30	50	4	125

Sr. No.	Title of MDM	Course Code	Course Name	Assessment guidelines (Marks)			Credits	Total marks (Passing @40% of total marks
				ISA	MSE	ESE		
6	Computer Science	MDMCS01	Computational Logic and Data Structures	45	30	50	4	125
		MDMCS02	)perating System & Computer Networks	45	30	50	4	125
		MDMCS03	atabase Systems & Introduction to Data Mining	45	30	50	4	125

Course Structure and Assessment Guidelines

	Course		Head of Learning	Credits	Assessment guidelines (Marks)			Total marks (Passing@ 40% of total marks)
NEP-Verticals	**Code**	**Name**			**ISA**	**MSE**	**ESE**	
PC_PCC	PCET14T	Mobile Communication	Theory	2	15	20	40	075
	PCET14P	Mobile Communication Lab	Practical	1	25	-	25	050
	PCET104T	RF and Microwave Engineering	Theory	2	20	30	50	100
	PCET104P	RF and Microwave Engineering Lab	Practical	1	25	-	25	050
PC_PEC	PEETXXT	Programme Elective-2	Theory	2	15	20	40	075
	PEETXXP	Programme Elective-2 Lab	Practical	1	25	-	25	050
	PEETXXT	Programme Elective-3	Theory	2	15	20	40	075
	PEETXXP	Programme Elective-3 Lab	Practical	1	25	-	25	050
MDM	MDMBDXX*	As per MDM course list##	As per course	4	45	30	50	125
HSSM_EEMC	EEMC03	Engineering Economics	Theory	2	15	20	40	075
ELC_INT/OJT	PRJET110	Project-1 (Synopsis)	Theory	2	50	-	25	075
Total Credit				**20**				

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESA= End Semester Examination
*Selection based on the subset of courses made available by the Institute for the semester.
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.

List of Programme Elective 2 Courses:

Course Code	Course Name	Specialization Track Name #
PEET21T	Telecommunication Network Management	Communication Engineering
PEET21P	Telecommunication Network Management Lab	

PEET27T	Introduction to Data Analytics	Data Analytics and Machine Learning
PEET27P	Introduction to Data Analytics Lab	
PEET33T	Principles of Internet of Things (IoT)	Internet of Things
PEET33P	Principles of Internet of Things (IoT)Lab	
PEET39T	Advanced VLSI Design and Technology	Very Large Scale Integration
PEET39P	Advanced VLSI Design and Technology Lab	

List of Programme Elective 3 Courses:

Course Code	Course Name	Specialization Track Name #
PEET22T	Tracking Systems	Communication Engineering
PEET22P	Tracking Systems Lab	
PEET28T	Machine Learning	Data Analytics and Machine Learning
PEET28P	Machine Learning Lab	
PEET34T	Embedded System Design with Tiny Operating System	Internet of Things
PEET34P	Embedded System Design with Tiny Operating System Lab	
PEEC40T	Analog IC Design	Very Large Scale Integration
PEEC40P	Analog IC Design Lab	

#For details of Specialization Certificate, refer Appendix-A

Multidisciplinary Minor (MDM)

Sr. No.	Title of MDM	Course Code	Course Name	Assessment guidelines (Marks)			Credits	Total marks (Passing @40% of total marks
				ISA	MSE	ESE		
1	-	MDM01	Seminar	25	-	50	2	75
2	Bioinformatics	MDMBI01	Introduction to Bioinformatics	45	30	50	4	125
		MDMBI02	Algorithms and Data Structures in Bioinformatics	45	30	50	4	125
		MDMBI03	Machine Learning Applications in Bioinformatics	45	30	50	4	125
3	Innovation, Entrepreneurship and Venture Development	MDMIE01	Foundations of Innovation and Entrepreneurship	45	30	50	4	125
		MDMIE02	Startup Planning and Development	45	30	50	4	125
		4MDMIE03	Innovation Management and Scaling Startups	45	30	50	4	125
4	Business Development, Marketing and Finance	MDMBD01	Introduction to Business Development and Marketing Principles	45	30	50	4	125
		MDMBD02	Financial Basics for Engineers and Technopreneurs	45	30	50	4	125
		MDMBD03	ategic Marketing and Business Planning	45	30	50	4	125
5	Robotics	MDMRB01	Fundamentals of Robotics and Control	45	30	50	4	125
		MDMRB02	Machine Vision and botic Perception	45	30	50	4	125
		MDMRB03	ntelligent Mobile	45	30	50	4	125

Sr. No.	Title of MDM	Course Code	Course Name	Assessment guidelines (Marks)			Credits	Total marks (Passing @40% of total marks
				ISA	MSE	ESE		
			Robotics					
6	Computer Science	MDMCS01	Computational Logic and Data Structures	45	30	50	4	125
		MDMCS02	Operating System & Computer Networks	45	30	50	4	125
		MDMCS03	Database Systems & Introduction to Data Mining	45	30	50	4	125

Detailed syllabus of Third Year Semester - V

Course Name: Basic VLSI Design

Course Code: PCET18T

Category: 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 Hours	**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: PCET18P

Category: 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 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:

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	Reduction of delay during adding two	CO5

		ahead adder with carry generation circuit using MODL	binary numbers	
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

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.
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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
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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: Computer Networks

Course Code: PCET107T

Category:
PC_PC

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:
Nil

Course Objectives:

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

Course Outcomes:

Students will be able to:

CO1: Demonstrate the concepts of data communication and compare ISO - OSI model with TCP/IP model.
CO2: Explore different design issues at data link layer.
CO3: Design the network using IP addressing and subnetting / super netting schemes.
CO4: Analyse various routing algorithms and protocols at network layer.
CO5: Analyse transport layer protocols and congestion control algorithms.
CO6: 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 (Dijkastra'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: PCET107P

Category:
PC_PCC

Preamble:

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

Pre-requisites:

Nil

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 Practical:

Learners are expected to perform practical 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 Supernetting
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

The above list is a mere suggestion. The course teacher may explore various ways available to investigate computer networks.

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: Digital Signal Processing

Course Code: PCET10T

Category:
PC_PCC

Preamble:
This course deals with the analysis and representation of discrete-time signal systems, including discrete-time convolution, difference equations, the discrete-time Fourier transform, and presentation of the fast Fourier transform algorithm for computation of the discrete Fourier transform. The course then proceeds to a consideration of digital network structures for implementation of both recursive (infinite impulse response) and non-recursive (finite impulse response) digital filters. The application of the concepts in the real world.

Pre-requisites:

Signals and System

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:

CO1: Understand the concepts of discrete-time Fourier transform, fast Fourier transform and apply in system analysis.
CO2: Design digital IIR filters to satisfy the given specifications.
CO3: Design digital FIR filters to satisfy the given specifications.
CO4: Interpret the different realization structures of Digital IIR and FIR filters.
CO5: Analyze the impact of hardware limitations on the performance of digital filters.
CO6: Apply signal processing concepts, algorithms in applications related to the field of biomedical signal processing.

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	Discrete Fourier Transform & Fast Fourier Transform	Introduction to Discrete Fourier transform (DFT), Properties of DFT. Fast Fourier Transform: Radix-2 Fast Fourier Transforms (FFT), Radix-2 decimation in time and decimation in frequency FFT algorithms, Inverse FFT Filtering of long data sequences: Overlap-Save and Overlap-Add Method	6
2	IIR Digital filters	Design of IIR digital filters (Butterworth and Chebyshev-I) from analog filters using impulse invariant and bilinear transformation techniques, Analog and digital frequency transformations	5
3	FIR Digital Filters	Characteristics of linear phase FIR digital filters, Symmetric and antisymmetric FIR filter, Location of the zeros of linear phase FIR filters, Minimum, maximum and mixed phase systems. Design of FIR filters using Window techniques (Rectangular, Hamming, Hanning, Blackman, Bartlett), Design of FIR filters using Frequency Sampling Technique.	6
4	Digital Filter Structures	Realization of FIR & IIR filters Cascade form and parallel form structures, Lattice Ladder structure, Computational complexities for N order filter	4
5	Finite Word Length Effects in Digital Filters	Rounding and truncation errors, Quantization error, Output noise power from a digital system. Product quantization, Noise model for direct form and cascaded IIR structure (first order), Coefficient quantization error and zero input limit cycle	5
6	Introduction to adaptive filtering	Introduction to Frequency domain filtering (notch Filter) optimal filtering: Weiner filter, adaptive filtering, biomedical applications ECG and tomographic imaging	4
Total			**30**

Textbooks:

1. Proakis J., Manolakis D., "Digital Signal Processing", 4th Edition, Pearson Education.
2. Emmanuel C. Ifeachor, Barrie W. Jervis," Digital Signal Processing", A Practical Approach", Pearson Education
3. A Nagoor Kani "Digital Signal Processing", 2nd Edition. Tata Mc Graw Hill Education Private Limited

Reference books:

1. Sanjit K. Mitra, "Digital Signal Processing – A Computer Based Approach ", 4th Edition McGraw Hill Education (India) Private Limited, 2013
2. Oppenheim A., Schafer R., Buck J., "Discrete Time Signal Processing", 2nd Edition, Pearson Education, 3rd Edition, 2010
3. L. R. Rabiner and B. Gold, "Theory and Applications of Digital Signal Processing", Prentice Hall of India, 2006.

Course Name: Digital Signal Processing Lab

Course Code: PCET10P

Category:
PC_PCC

Preamble:

This course is to provide students with an overview of the concepts and fundamentals of digital signal processing.

Pre-requisites: Nil

Course Objectives:

1. To carry out basic discrete time signal processing operations.
2. To implement and design FIR filters and IIR filters.
3. To implement applications related to the field of biomedical signal processing and audio signal processing.

Course Outcomes:

Learner will be able to:

CO1: Perform basic discrete time signal processing operations such as Linear Convolution, Circular Convolution, Auto Correlation, Cross Correlation, etc. and interpret the results.
CO2: Demonstrate their ability towards interpreting and performing frequency analysis of different discrete time sequences and systems.
CO3: Design and implement the FIR and IIR Filters for given specifications.
CO4: Implement and Analyse applications related to the field of biomedical signal processing and audio signal processing.

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 Practical:

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

Sr No	Suggested Topic(s)
1	To perform linear convolution of two signals, auto correlation of non-periodic signals, periodic signals and random noise and interpret the results obtained.
2	To linearly convolve swept frequency sinusoidal wave with LPF and HPF impulse response filters in time domain and interpret the results obtained.
3	To obtain cross correlation of a signal with its delayed and attenuated version (Concept of radar signal processing).
4	To perform the DFT of DT sequence and sketch its magnitude and phase spectrum or To Generate a discrete time signal having minimum three frequencies and analyse its frequency spectrum.
5	DFT based spectral analysis to detect the signal buried in noise.
6	To perform denoising of a speech signal using circular convolution.
7	Design of IIR digital filters and use the designed filter to filter an input signal which has both low and high frequency components or real-world signal like ECG/EEG, speech signal etc).
8	Design a notch filter to supress the power supply hum in audio signals.
9	To read an ECG signal and separate the QRS Complex.
10	To extract delta, theta, alpha, sigma, and beta waveforms from EEG signal.

The above list is a mere suggestion. The course teacher may explore different signal processing techniques and applications.

Textbooks:

1. Digital signal processing Principles Algorithms and Application – Proakis & Manolakis, Third edition PHI
2. Digital Signal Processing – Sanjit K. Mithra Tata Mc-graw Hill.
3. Emmanuel C. Ifeachor, Barrie W. Jervis," Digital Signal Processing", A Practical Approach", Pearson Education

Reference Books:

1. S Salivahan, C Gnanapriya, "Digital Signal Processing", Mc Graw Hill Education (India) limited, 4th Edition, 2015
2. Monson H Hayes, "Digital Signal Processing", Schaum's Outline Series, 2nd Edition, 2011

Course Name: Electromagnetics and Antenna

Course Code: PCET103T

Category: PC_PCC

Preamble:

This course present essentials of electromagnetics. The electromagnetic phenomenon can be summarized in the form of Maxwell's equation. These equations are based on previously known theoretical and experimental results. Antenna radiates electromagnetic energy. This course will discuss radiation mechanism, purpose, parameters, and types of antennas.

Pre-requisites: Nil

Course Objectives:

The objective of the course is to make student familiar with Maxwell's equation and its usefulness to describe different electromagnetic phenomena such as wave propagation, power in electromagnetic wave, radiations from antenna, analysis and design of antenna.

Course Outcomes:

Student will be able to:

CO1: Describe electromagnetics field including static and dynamic in terms of Maxwell's equations.
CO2: Apply Maxwell's equation to solve various electromagnetic phenomenon such as electromagnetic wave propagation in different medium, power in EM wave and radiations from wire elements.
CO3: Evaluate the performance of antennas using parameters like gain, directivity, efficiency, bandwidth, and polarization etc.
CO4: Design different types of the antenna structures such as antenna arrays, microstrip antenna, horn antenna, and reflector antenna etc.
CO5: Describe different mechanisms of radio wave propagation.

Course Scheme:

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

Assessment Guidelines:

Head	ISA	MSA	ESA	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 Static fields	Charge, Coulomb's law, Charge configurations, Electric field intensity, Electric flux density, Gauss's law and applications, Current density, and Continuity equation. Scalar Electric Potential, Potential gradient, Laplace's, and Poison's equations. Biot-Savart Law, Ampere Circuit law, Gauss's law for magnetic field, Vector magnetic potential.	6
2	Electromagnetic Field and Maxwell's Equations	Faraday's Law, Displacement current density, Maxwell's equation for time varying filed, Boundary conditions. EM wave propagation through lossy, perfect dielectric and conducting medium. Power in EM Wave: Poynting theorem and Poynting vector.	6
3	Basic of Antennas	Basic concepts: Radiation mechanism, Near field and far field radiation, retarded potential. Antenna Parameters: Isotropic antenna, Radiation pattern, radiation intensity, Beamwidth, directivity, Gain, beam efficiency, bandwidth, polarization, Input impedance, Antenna efficiency, Radiation resistance, Loss resistance, aperture concept, FRII's transmission formula. Wire Elements: Infinitesimal dipole, Wire dipole, Monopole antennas: radiation field and related parameters.	6
4	Antenna Arrays	Linear arrays of two isotropic point sources, linear arrays of N elements, Principle of pattern multiplication Introduction to planner, circular array. Concept of phased array. Introduction to array synthesis using Binomial array.	4
5	Types of antennas	Yagi antenna, Broadband antenna like Helical and Log Periodic antenna. Horn Antennas: E-Plane Sectoral Horn, H-Plane Sectoral Horn, Pyramidal Horn, and Conical Horn. Reflector Antennas: Plane Reflectors, Corner Reflectors and Parabolic Reflector. Patch Antenna: Microstrip antenna, Feeding Techniques, Introduction to design of Microstrip	6

		antenna (Rectangular and circular patch).	
6	Electromagnetic Wave Propagation	Introduction to Ground Wave Propagation, Sky Wave Propagation and Space Wave Propagation.	2
		Total	**30**

Textbooks:

1. Matthew N. O. Sadiku, S.V. Kulkarni, "Principles of Electromagnetics Engineering", Oxford university press, 6th Edition.
2. Costantine A. Balanis, "Antenna Theory: Analysis and Design", John Wiley Publication, 4th Edition

Reference Books:

1. William H Hayt and John A Buck, "Engineering Electromagnetics", Tata McGraw-Hill Publishing Company Limited, 7th Edition.
2. John D Kraus, A S Khan, "Antenna and wave Propagation", McGraw Hill, 4th Edition .

Course Name: Electromagnetics and Antenna Lab

Course Code: PCET103P

Category: PC_PCC

Preamble:
This course introduces learners to the different methods used to analyze, synthesize, and numerically compute the radiation characteristics of antennas. In addition, the learners will experimentally investigate the antenna performance to validate theoretical results.

Pre-requisites: Nil

Course Objectives:

- Investigate electromagnetic problems using Maxwell's equation.
- Understand types of antennas and radiation mechanisms.
- Describe antenna performance in terms of various parameters.
- Understand the design details of the antenna and simulate different antennas for given
- specifications.
- Experimentally investigate the antenna performance.

Course Outcomes:

CO1: Apply Maxwell's equation to solve various electromagnetic phenomenon.
CO2: Demonstrate antenna performance in terms of different antenna performance parameters.
CO3: Design and simulate different types of the antenna structures such as Linear wire, Antenna arrays, Microstrip antenna and reflector antenna etc. using electromagnetic simulation tools.
CO4: Measure and interpret antenna parameters using lab instruments.

Course Scheme:

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

Assessment Scheme:

Head	ISA	MSA	ESA	Total
Practical	25	-	25	50

Suggested List of Practical:

- Investigation of electromagnetic problems such as electromagnetic wave motion through different mediums using Maxwell's equation
- Antenna radiation mechanism and current distribution along linear wire antennas
  - ✓ Understand how the electromagnetic fields are generated by the antenna and its detachment from the antenna to form a free-space wave.
  - ✓ Classification of linear wire antenna.
  - ✓ Visualize current distribution along dipole antenna.
- Design and analysis of half wave dipole antenna.

- ✓ Understand design details of half wave dipole antenna. Design half wave dipole at different frequencies and find its parameters like impedance, radiation pattern, directivity, and beamwidth of antenna.

- Design and analysis of Yagi Uda Antenna.
  - ✓ Design Yagi Uda antenna for different frequency bands.
  - ✓ List design details.
  - ✓ Simulate using CAD tools.
- Design and analysis of Log Periodic Antenna.
  - ✓ Design log periodic antenna for different frequency ranges.
  - ✓ List design details.
  - ✓ Simulate using CAD tools.
- Measurement of radiation pattern of Yagi Uda and Log Periodic antenna.
- Measurement of performance parameter of Microstrip antenna using Vector Network Analyzer (VNA).
- Design and Simulation of microstrip antenna, antennas arrays, helical antennas etc.

The above list is a mere suggestion. The course teacher may explore various ways available to investigate electromagnetic problems and antenna performance.

Textbooks:

1. Matthew N. O. Sadiku, S. V. Kulkarni, "Principles of Electromagnetics Engineering", Oxford university press, 6th Edition.
2. Costantine A. Balanis, "Antenna Theory: Analysis and Design", John Wiley Publication, 4th Edition .

Reference Books:

1. William H Hayt and John A Buck, "Engineering Electromagnetics", Tata McGraw-Hill Publishing Company Limited, 7th Edition.
2. John D Kraus, A S Khan, "Antenna and wave Propagation", McGraw Hill, 4th Edition .

Course Name: Modelling and Analysis of Communication Systems.

Course Code: PEET20T

Category: PC_PEC

Track Name: Communication Engineering

Preamble:

Modeling and analysis of Communication Systems provides a comprehensive understanding of Communication fundamentals, Transmission requirements, analytical modeling, and mathematical tools. The course explores the different communication channel models and their performance analysis. The course also provides insights on different measures used to ensure quality of transmission of advanced communication systems.

Pre-requisites:

Principles of Communication Engineering (SEM-IIII), Digital communication (IV)

Course Objectives:

- To identify factors degrading the signal quality in telecommunication transmission
- To model different communication channels.
- To understand different tools used for performance analysis of communication systems.

Course Outcomes:

Learner will be able to:

CO1: To identify different channels of communication.
CO2: To compare error performance of different communication system.
CO3: To analyze the effect of noise on channel capacity.
CO4: To apply different tools for performance analysis of communication systems.
CO5: To Understand physical channel models of wireless transmission.

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 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	Overview of communication system	Elements of communication system, Desirable characteristics of communication systems, Communication channel models, Significance of time domain and frequency domain analysis, Performance limiting factors and effect of Noise on transmission.	3
2	Mathematical Foundations for Communication Engineering	Probability and its significance, Information theory and data compression for efficient transmission, Mutual information and channel capacity. Capacity of different communication channels, Effect of noise on channel capacity.	3
3	Baseband and bandpass communication	Desirable characteristics of communication channel, Sources and types of errors. Error performance and bandwidth efficiency of communication system. Performance limiting factors for baseband transmission, Bandpass modulation schemes and their comparative analysis, performance analysis of coherent and Noncoherent detection.	6
4	Performance analysis and optimization techniques	Noise performance of analog communication system, Analytical model for error performance of communication system, different tools used performance analysis. Bit error rate analysis by using BER tool, Constellation diagram, Performance analysis of different communication systems by using constellation diagram, Optimization of BER by using error control techniques.	6
5	Wireless Channel modeling and analysis	Radio wave propagation, Physical modeling for wireless channels, AWGN channel capacity, capacity of flat fading channels, Capacity of frequency selective fading channels-time invariant- time variant, diversity analysis, Performance of digital modulation over wireless channel, Equalization and its types.	6
6	Wireless Optical channel analysis	Wireless optical channels: atmospheric channel, underwater optical channel, atmospheric losses, weather condition influence, atmospheric turbulence effects i.e. scintillation, beam spreading, etc. wireless optical communication application areas, WOC challenges.	6
Total			**30**

Textbooks:

1. "Electronic Communications System", Wyne Thomasi, Pearson Fifth Edition.
2. "Communications System", Simon Hykin, Pearson, Fifth Edition.
3. "Digital communication", Proakis, Mc-Graw Hill, Fifth edition.
4. "Digital communication", Hykin, Wiley Publication.
5. 'Wireless Communications Principles and Practice", Theodore S. Rappaport, Third Edition, Pearson Education.
6. Optical Wireless Communications, Z. Ghassemlooy, W. Popoola, S. Rajbhandari, CRC Press.

Reference Books:

1. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, decentralization, and smart contracts explained", 2nd Edition, Packt Publishing Ltd, March 2018.
2. Simulation of communication system, Modeling, Methodology and Techniques, Information Technology: Transmission, Processing and Storage, Second edition.

Course Name: Modelling and analysis of Communication Systems Lab

Course Code: PEET20P

Category: PC_PEC

Track Name: Communication Engineering

Preamble:

This lab course provides a hands-on experience to complement the theoretical knowledge gained for theoretical concepts of communication systems lectures. This lab provides students with a strong foundation in communication system analysis and design principles. By actively participating in the experiments and analyzing the results, students will develop critical thinking skills, problem-solving abilities, and practical experience relevant to the field of communication engineering.

Pre-requisites:

Principles of Communication Engineering (Sem-III), Digital communication (Sem-IV)

Course Objectives:

- Develop skills in modeling and signal analysis.
- Understand the performance of different communication channels
- Analyse the impact of noise and interference on communication systems.
- Evaluate the performance of digital communication systems using Bit Error Rate

Course Outcomes:

CO1: Students will be able to design, simulate, and analyze basic analog communication systems using modulation and demodulation techniques.
CO2: Students will be able to measure and interpret signal characteristics in both time and frequency domains.
CO3: Students will be able to assess the effects of noise and interference on communication signals and propose mitigation strategies.
CO4: Students will be able to implement and analyze various digital modulation schemes, evaluating their performance based on BER.
CO5; Students will be able to analyze the performance of different communication channels.

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:

Sr. No.	List of experiments
1	Comparative analysis of analog communication system by using time domain and frequency domain analysis
2	Analysis of analog communication system in presence of white noise
3	Performance analysis of AWGN communication channel
4	Performance analysis of wireless fading channels
5	Noise performance of bandpass system by using constellation diagram
6	Bit error rate analysis of digital communication system
7	Optimization of BER using error control system
8	BER analysis of AWGN, Rayleigh and Rician channels
9	EVM performance analysis of different digital modulation techniques
10	Transmission analysis of wireless optical signals for different atmospheric conditions

Textbooks:

1. "Electronic Communications System", Wyne Thomasi, Pearson Fifth Edition.
2. "Communications System", Simon Hykin, Pearson, Fifth Edition.
3. "Digital communication", Proakis, Mc-Graw Hill, Fifth edition.
4. "Digital communication", Hykin, Wiley Publication.
5. 'Wireless Communications Principles and Practice", Theodore S. Rappaport, Third Edition, Pearson Education.
6. Optical Wireless Communications, Z. Ghassemlooy, W. Popoola, S. Rajbhandari, CRC Press.

Reference Books:

1. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, decentralization, and smart contracts explained", 2nd Edition, Packt Publishing Ltd, March 2018.
2. Simulation of communication system, Modeling, Methodology and Techniques, Information Technology: Transmission, Processing and Storage, Second edition.

Course Name: Database Management Systems

Course Code: PEET26T

Category: PC_PEC

Track Name: Data Analytics and Machine Learning

Preamble:

The Database Management Systems course is intended to deliver students the elementary concepts of a database management system. It also introduces advanced level areas like transaction processing, concurrency control and recovery management.

Pre-requisites:

Data Structures & Analysis of Algorithms (ET07T)

Course Objectives:

- To learn the basics and understand the need of database management system.
- To construct conceptual data model for real world applications
- To Build Relational Model from ER/EER.
- To introduce the concept of SQL to store and retrieve data efficiently.
- To demonstrate notions of normalization for database design.
- To understand the concepts of transaction processing- concurrency control & recovery procedures.

Course Outcomes:

Learner will be able to:

CO1: Identify the need for Database Management System.
CO2: Design conceptual models for real life applications.
CO3: Create Relational Model for real life applications
CO4: Formulate query using SQL commands.
CO5: Apply the concept of normalization to relational database design.
CO6: Demonstrate the concept of transaction, concurrency control, and recovery.

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 Database Systems	Introduction, Characteristics of Database, File system v/s Database system, Advantages and disadvantages of database, Data abstraction, Data independence, Database users, database languages, DBMS system architecture, Database Administrator (DBA), Role of DBA	4
2	The Entity-Relationship Model	The Entity-Relationship (ER) Model, Entity and its types, Attributes and types of attributes, Relationship Types, Relationship Sets, Mapping Cardinality, ER diagram Generalization, Specialization, Aggregation, Extended Entity-Relationship (EER) Model.	4
3	Relational Model & Relational Algebra	Introduction to Relational Model, Relational Model Constraints and Relational Database Schemas, Concept of Keys: Primary Kay, Secondary key, Foreign Key, Mapping the ER and EER Model to the Relational Model, Introduction to Relational Algebra, Relational Algebra Operators, Relational Algebra Queries	5
4	Structured Query Language (SQL)	Overview of SQL, Data Definition Commands, Set Operations, null values, Data Manipulation Commands, Data Control Commands, Complex Retrieval Queries using Group By, Nested queries, Integrity constraints in SQL. Security and authorization: Grant & Revoke in SQL, Aggregate functions, Hierarchical retrieval of data Functions and Procedures in SQL, cursors. Trigger and its types	7
5	Relational Database Design	Design guidelines for relational Schema, Functional Dependencies and types, Database tables and normalization, Need for normalization, Definition of Normal Forms- 1NF, 2NF, 3NF & The Boyce-Codd Normal Form (BCNF), introduction to multi valued dependency	6
6	Transaction Management, Concurrency & Recovery	Transaction concept, State Diagram, ACID Properties, Transaction Control Commands, Concurrent Executions, Serializability – Conflict and View, Concurrency Control: Lock-based-protocols, Deadlock handling Timestamp-based protocols Recovery System: Recovery Concepts, Log based recovery methods.	6
Total			**30**

Textbooks:

1. Korth, Slberchatz, Sudarshan, Database System Concepts, 6th Edition, McGraw Hill
2. Elmasri and Navathe, Fundamentals of Database Systems, 6th Edition, Pearson education

Reference Books:

1. Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH
2. Peter Rob and Carlos Coronel, — Database Systems Design, Implementation and Management, Thomson Learning, 9th Edition.
3. SQL & PL / SQL for Oracle 11g Black Book, Dreamtech Press
4. G. K. Gupta: "Database Management Systems", McGraw – Hill

Course Name: Database Management Systems Lab

Course Code: PEET26P

Category: PC_PEC

Track Name: Data Analytics and Machine Learning

Preamble:

The Database Management Systems course is intended to deliver students the elementary concepts of a database management system. It also introduces advanced level areas like transaction processing, concurrency control and recovery management.

Pre-requisites:

Structured Programming Lab (ES04P)

Course Objectives:

- To identify and define problem statements for real life applications
- To construct conceptual data model for real life applications
- To Build Relational Model from ER/EER and demonstrate usage of relational algebra.
- To Apply SQL to store and retrieve data efficiently

Course Outcomes:

Learner will be able to:

CO1: Design ER model for given real world application
CO2: Design Relational model for real world application
CO3: Write and execute DDL statements
CO4: Write and execute DML statements
CO5: Write and execute TCL statements
CO6: Design PL/SQL procedures and functions

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 Practical:

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

Sr No	Suggested Topic(s)
1	Identify real world problems and develop the problem statement. Design an Entity-Relationship (ER) / Extended Entity- Relationship (EER) Model.
2	Mapping ER/EER to Relational schema model.
3	Create a database using DDL and apply integrity constraints.
4	Perform data manipulations operations on populated database.
5	Perform Authorization using Grant and Revoke.
6	Implement Basic and complex SQL queries.
7	Implementation of Views and Triggers.
8	Demonstrate database connectivity using JDBC.
9	Execute TCL commands.
10	Implement functions and procedures in SQL
11	Implementation of Cursor.
12	Mini Project

Textbooks:

1. SQL & PL / SQL for Oracle 11g Black Book, Dreamtech Press

Reference Books:

1. G. K. Gupta: “Database Management Systems”, McGraw – Hill

Course Name: Modern Sensors for Internet of Things

Course Code: PEET32T

Category: PC_PEC

Track Name: Internet of Thing

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 application using one or more sensor.

Course Scheme:

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

Assessment Guidelines:

Head	ISA	MSA	ESA	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: PEET32P

Category: PC_PEC

Track Name: Internet of Things

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 sensor types and their characteristics.
- To understand different types of sensors and their application.
- To understand communication protocol and their use in sensor network.
- To understand various types of 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 the 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 Hour		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment Scheme:

Head	ISA	MSA	ESA	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:

- 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 parameters 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 sensors and a communication protocol.

Textbooks:

1. Jacob Fraden, "Handbook of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York.
2. Jon. S. Wilson, "Sensor Technology Handbook", 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.
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: Digital System Design

Course Code: PEET38T

Category: PC_PEC

Track Name: Very Large Scale Integration

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 be introduced to VERILOG, a hardware description language widely used in digital design.
- Design various Combinational and Sequential circuits using VERILOG.

Course Outcomes:

Students will be able to:

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	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: PEET38P

Category: PC_PEC

Track Name: Very Large Scale Integration

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 be introduced to VERILOG, a hardware description language widely used in digital design.
- Design various Combinational and Sequential circuits using VERILOG.

Course Outcomes:

Students will be able to:

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	Implement different counters and compare their performance	1,2,3,4,5

		FPGA.		
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

Detailed syllabus of Third Year Semester – V
Multidisciplinary Minor (MDM)

Course Name: Introduction to Business Development and Marketing Principles

Course Code: MDMBD01

Category: 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:

Student 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	Tutorial	Theory	Tutorial
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	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**

PO Mapping by Module:

- Module 1: PO6, PO8, PO12
- Module 2: PO3, PO6, PO10
- Module 3: PO2, PO10
- Module 4: PO1, PO3, PO5
- Module 5: PO4, PO11
- Module 6: PO9, PO10

Textbooks:

1. Marketing Management by Kotler

Reference Books:

1. Marketing Basics PDF by MIT OpenCourseWare

Course Name: Introduction to Bioinformatics

Course Code: MDMBI01

Category: 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.

Pre-requisites:

None

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:

Learner will be able to:
CO1: understand the basic principles of bioinformatics.
CO2: understand foundational understanding of biology, types of biological data, and the role of computing in biology.

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	Explain foundational molecular biology concepts and their relevance to bioinformatics, including DNA, RNA, proteins, and gene functions.	Understanding
CO2	Access, compare, and utilize various biological databases and sequence file formats to retrieve and analyze genomic and proteomic data effectively.	Applying
CO3	Apply key sequence alignment algorithms and computational techniques to analyze biological sequences and construct phylogenetic relationships.	Applying
CO4	Implement bioinformatics algorithms and data structures to solve problems in genomics, proteomics, and systems biology, including gene prediction and motif discovery.	Applying
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.	Analyse

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 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	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. ***Self-Learning Topics***: *Overview of transcription factors, epigenetics, and recent genetic editing technologies (CRISPR).*	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) ***Self-Learning Topics****: Meta-databases and integrative resources (e.g., UniProt, INSD)*	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 ***Self-Learning Topics****:* Evolutionary models used in sequence analysis	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 ***Self-Learning Topics****: Public repository of genomic data*	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 Laborator 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: Fundamentals of Robotics and Control

Course Code: BDMRB01

Category: 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 prin ciples 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:

Course Code	Contact Hours		Credits Assigned	
	Theory	Practical	Theory	Practical
MDMBI01	3	2	3	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory+ Practical	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

Module No.	Module Name	Module Contents	No. of Hours
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

Course Name: Computational Logic and Data Structures

Course Code: MDMCS01

Category: MDM

Preamble:

The course introduces students to key concepts in discrete structures and data structures, providing a foundational understanding essential for many areas in computer science. Students will explore topics related to the organization, management, and manipulation of data, as well as learn about basic data structures, their associated algorithms, and principles of design and analysis. Emphasis will be placed on both theoretical understanding and practical application, enabling students to effectively use these concepts to solve complex computational problems.

Pre-requisites:

1. ES04T (Structured Programming).
2. ES05T (Object Oriented Programming)

Course Objectives:

- To establish foundational knowledge of discrete mathematical structures and their properties, enabling students to recall and apply these concepts in computational problem-solving.
- To develop conceptual understanding of linear/non-linear data structures (stacks, queues, trees, graphs), their memory representations, and operational principles for efficient data organization.
- To build practical skills in implementing, analyzing, and optimizing data structure operations while evaluating time/space complexity using asymptotic notations.
- To apply integrated knowledge of discrete mathematics and data structures to design solutions for real-world engineering challenges.

Course Outcomes:

Learner will be able to:

CO1: Recall fundamental concepts of set theory, logic, relations, and algebraic structures, including definitions, properties, and notations.
CO2: Explain the working principles of linear and non-linear data structures (stacks, queues, trees, graphs) and their representations in memory.
CO3: Explain the principles of linear and non-linear data structures (stacks, queues, trees, graphs) and their memory representations.
CO4: Implement basic operations (insert/delete/search) on linear data structures (arrays, stacks, queues, linked lists) using appropriate programming constructs.
CO5: Analyze and compare time/space complexity of different data structure implementations using asymptotic notations (Big-O, Omega, Theta).
CO6: Evaluate the application of discrete mathematical concepts (graph theory, algebraic structures) in solving engineering problems like network design or cryptography.

Course Scheme:

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

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory + Practical	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	Set Theory and Logic	Definition and representation of Sets, Types of sets, operations on sets, Laws of set, Principle of Inclusion & Exclusion (3 sets), Partition of set. Counting principle, Pigeonhole Principle, Mathematical Induction.	6
2	Relations and Functions	Relation: Definition, Representation of relation, Properties of relation, Closure properties of relation (Reflexive, Symmetric and Transitive), partial order and equivalence relation. Function: Definition, Types of function, Inverse function, composite functions.	8
3	Algebraic Structures	Algebraic structures with one binary operation: Groupoid, Semigroup, Monoid and Group, Abelian group, Cyclic groups, order and subgroup, Group Homomorphism, Isomorphism and Automorphism.	7
4	Introduction to Data Structures and Complexity	Introduction to Data Structures, Types of Data Structures-Linear and Nonlinear, Operations on Data Structures. Time Complexity of Algorithm. Space Complexity of Algorithm. Notations (Big O, Omega and Theta).	4
5	Stack, Queue and Linked List	Introduction of Stack, Operations on Stack, Array Implementation of Stack. Introduction of Queue, Operations on Queue, Array Implementation of Queue, Types of Queue-Circular Queue, Priority Queue, Double Ended Queue. Introduction to Linked List, Representation of Linked List,	10

Module No	Module name	Content	No of Hours
		Linked List v/s Array, Singly Linked List.	
6	Graph and Trees	Introduction to Graph , Graph Terminologies, Representation of Graph, Graph Traversals-Depth First Search (DFS) and Breadth First Search (BFS). Introduction to Tree, Tree Terminologies, Binary Tree, Types of Binary Tree, Binary Tree Traversals. Binary Search Tree, Operations on Binary Search Tree. Applications of Binary Tree-Expression Tree, Huffman Encoding	10
Total			**45**

Text Books:

1. C. L. Liu, "Elements of Discrete Mathematics", TMH, ISBN 10:0-07-066913-9.
2. N. Biggs, "Discrete Mathematics", 3rd Ed, Oxford University Press, ISBN 0 –19-850717–8.
3. Kenneth H. Rosen, "Discrete Mathematics and its Applications", Tata McGraw-Hill, ISBN 978- 0-07-288008-3
4. Cryptograph and Network Security by B. A. Forouzan & D. Mukhopadhyay, 11th edition, McGraw Hill Publication.
5. Network Security and Cryptograph by Bernard Menezes, Cengage Learning Publication.
6. Reema Thereja," Data Structures using C", 2nd edition, Oxford Press, 2014
7. Aaron M Tenenbaum, Yedidyah Langsam, Moshe J Augenstein, "Data Structures Using C", First Edition, Pearson Publication, 2019

Reference Books:

1. Bernard Kolman, Robert C. Busby and Sharon Ross, "Discrete Mathematical Structures",Prentice-Hall of India /Pearson, ISBN: 0132078457, 9780132078450.
2. Narsingh Deo, "Graph with application to Engineering and Computer Science", Prentice Hall of India, 1990, 0 – 87692 – 145 – 4.
3. Eric Gossett, "Discrete Mathematical Structures with Proofs", Wiley India Ltd, ISBN:978-81-265-2758-8.

Detailed syllabus of Third Year Semester - VI

Course Name: Mobile Communication

Course Code: PCET14T

Category: PC_PCC

Preamble:
This course introduces learners to the understanding of Cellular fundamentals and different types of radio propagation models. It makes learners understand the evolution of 2G and 3G mobile technologies. It also gives insights on details of LTE architecture. Learners will be introduced to the concepts of emerging technologies for 4 G standards and beyond.

Pre-requisites: Digital Communication

Course Objectives:

- To understand the cellular fundamentals and different types of radio propagation models.
- To study evolution of 2G and 3G mobile technologies
- To illustrate the working principle of LTE.
- To learn the concepts of emerging technologies for 4 G standards and beyond

Course Outcomes:

Student will be able to:

CO1: Understand the cellular fundamentals and estimate the coverage and capacity of cellular systems
CO2 Classify different types of propagation models and explain the link budget.
CO3: Summarize the fundamentals and system architecture of GSM, 2,5G and IS-95.
CO4: Analyse the concepts of 3G technologies of UMTS and CDMA 2000
CO5: Explain the principles of 3GPP LTE.
CO6: Understand the emerging technologies for upcoming mobile communication systems.

Course Scheme:

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

Assessment Guidelines:

Head	ISA	MSA	ESA	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	Fundamentals of Mobile Communication	Introduction to Wireless Communication, The Cellular Concept System Design Fundamentals: Frequency reuse, Channel assignment strategies, Interference and system capacity, Trunking and Grade of service, Improving Coverage and Capacity in Cellular System and related problems.	4
2	Mobile Radio Propagation	Large scale fading: Free space propagation model, ground reflection (two-ray) model, practical Link budget design using path loss models. Self-learning: Basic propagation mechanisms, reflection, diffraction and scattering. Small scale fading: Small-scale multipath propagation, parameters of mobile multipath channels, types of small-scale fading, Rayleigh and Ricean distributions. Features of all conventional multiple access techniques: Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Space Spectrum Multiple Access (SSMA), Space Division Multiple Access (SDMA), Orthogonal Frequency Division Multiple Access (OFDMA), OFDM-PAPR	7
3	2G Technologies	GSM: GSM Network Architecture, air interface specifications, GSM signalling protocol architecture, GSM channels, GSM services and features, GSM multiframe structure, GSM speech coding, GSM Call procedures, Authentication and security in GSM, and handoff procedures in GSM. GSM evolution: GPRS, HSCSD and EDGE architecture, radio specifications IS-95: CDMA air interface, CDMA channels, power control in CDMA system, handoff, and RAKE receiver	6
4	3G Technologies	UMTS: Objectives, standardization and releases, network architecture, air interface specifications, channels, security procedure, W-CDMA air interface, attributes of WCDMA system, W-CDMA channels Cdma2000 cellular technologies: Forward and Reverse Channels, Handoff and Power Control	5
5	3GPP LTE	Introduction, system overview: Frequency bands and spectrum flexibility, network structure, protocol structure, Physical layer: Frames, slots, and symbols, modulation, coding, multiple-antenna techniques Logical and Physical Channels: Mapping of data onto (logical) sub-channels, Establishing a connection, Physical layer retransmissions and reliability, Power control, and handover.	5
6	Advanced techniques	Multi-antenna Techniques: Smart antennas, Multiple	3

	for 4G deployment and beyond	input Multiple output systems. Cognitive radio: Architecture, spectrum sensing. Software Defined Radio (SDR): Components and Applications. Introduction to 5G network and technologies used in 5G such as small cell concept, Massive MIMO, Beamforming, NOMA, and mm wave).	
Total			**30**

Textbooks:

1. T. L. Singal "wireless communications", Mc Graw Hill Education.
2. Theodore S. Rappaport "wireless communications - principles and practice", PEARSON, Second edition.
3. Andreas F. Molisch "wireless communications" WILEY INDIA PVT LTD, Second edition.

Reference Books:

1. Upena Dalal "Wireless and Mobile Communications||", Oxford university Press
2. Vijay K.Garg "Wireless Communications and Networking" ,Morgan–Kaufmann series in Networking
Elsevier.
3. J. H. Reed, Software-Defined Radio, Prentice-Hall, 2002
4. W. C. Y. Lee, Mobile Communication, Wiley
5. David Tse, Pramod Viswanath "Fundamentals of Wireless Communication" published by Cambridge University Press

Course Name: Mobile Communication Lab

Course Code: PCET14P

Category: PC_PCC

Preamble:

This course introduces learners to the understanding of fundamental of Number systems, basic analog digital circuits like diode, BJT, Gates etc. and their applications. It also gives the insights of Boolean algebra. It will motivate the learners to design combinational logic circuits and demonstrate them during practical.

Pre-requisites: Digital Communication

Course Objectives:

- To understand fundamentals and design parameters of cellular system.
- To Classify different types of propagation models
- To examine orthogonality principle of CDMA Systems
- To understand and simulate the working principles of MIMO.

Course Outcomes:

Student will be able to:

CO1 Demonstrate the effect of cellular system design parameters on system capacity and quality of service.
CO2: Compare and contrast trunking radio systems
CO3: Examine effect of small-scale fading parameters on the performance of radio channel
CO4: Demonstrate orthogonality principle of CDMA Systems
CO5: Simulate the working principles of MIMO system

Course Scheme:

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

Assessment Scheme:

Head	ISA	MSA	ESA	Total
Practical	25	-	25	050

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:

1) To observe the effect of velocity and direction of arrival of a vehicle on Doppler frequency
2) To observe the effect of incidence angle on reflection coefficient
3) To observe and compare the effect of Traffic intensity and number of trunked channels on the Blocking probability of a Trunked system
4) Select and justify the choice of cluster size in wireless network design which gives optimum capacity and acceptable voice quality for a voice call.
5) To plot Knife edge diffraction gain as a function of Fresnel diffraction parameter
6) To generate OVSF (orthogonal Variable Spreading factor) codes for 3G-WCDMA/UMTS system
7) To generate and check the orthogonality of the 64 Walsh Codes each of 64 bits that is generated for 64 logical channels used in IS-95 system using Hadamard Matrix. Extend the result to generate 128 bit Walsh code for CDMA 2000 system
8) To validate Shannon Hartley theorem and plot channel capacity versus SNR for different MIMO systems.
9) To study the effect of distance and frequency of operation on propagation path loss for various propagation models
10) To observe the effect of Cluster size and channel bandwidth on spectrum efficiency (Radio capacity), while providing an acceptable quality of service (QoS)

Note: - Above is the suggested list of practical and teacher can implement different problem statements using modern tools

Textbooks:

1. T. L. Singal “wireless communications”, Mc Graw Hill Education.
2. Theodore S. Rappaport “wireless communications - principles and practice”, PEARSON, Second edition.
3. Andreas F. Molisch “wireless communications” WILEY INDIA PVT LTD, Second edition.

Reference Books:

1. Upena Dalal “Wireless and Mobile Communications||”, Oxford university Press
2. Vijay K.Garg “Wireless Communications and Networking” ,Morgan–Kaufmann series in Networking-Elsevier
3. J. H. Reed, Software-Defined Radio, Prentice-Hall, 2002
4. W. C. Y. Lee, Mobile Communication, Wiley
5. David Tse, Pramod Viswanath “Fundamentals of Wireless Communication” published by Cambridge University Press

Course Name: RF and Microwave Engineering

Course Code: PCET104T

Category: PC_PCC

Preamble:

This course aims to provides a comprehensive introduction to the principles and practices of RF and Microwave Engineering. It will cover principles and design concepts of impedance matching circuits, microwave filters and microwave active and passive devices and circuits. The emphasis is on the concepts necessary for the analysis and design of RF and microwave circuits such as modern communication systems, satellite, radar, navigation, and sensing technologies etc.

Pre-requisites: Electromagnetics and Antenna

Course Objectives:

The objective of the course is to equip students with the necessary knowledge and skills to excel in the field of RF and microwave engineering. The followings are course objectives-

- Introduce the fundamental principles, concepts and practices of RF and Microwave engineering
- Designing impedance matching circuits at high frequency using lumped and distributed elements.
- Study the characteristics and operation of microwave passive and active devices such as waveguides, cavities, filters, microwave tubes and semiconductor devices.
- Characterization and estimation of noise and its effects in rf and microwave systems.
- Familiarize students with practical measurement techniques and modern simulation tools used in RF engineering.
- Develop an understanding of real-world applications in communication systems, radar, and satellite technologies.

Course Outcomes:

Student will be able to:

CO1: Design matching circuits using lumped and distributed elements.
CO2: Design passive rf and microwave filters for specific frequency responses and impedance requirements.
CO3: Analyse waveguide, waveguide components using scattering parameters and field theory.
CO4: Illustrate the concepts of noise and its impact on system performance in RF and microwave circuits.
CO5: Design basic RF amplifier and oscillator using semiconductor devices.

Course Scheme:

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

Assessment Guidelines:

Head	ISA	MSA	ESA	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	Impedance Matching and Tunning	• Introduction to RF and Microwave Engineering • Review of Transmission line equations and its solution • Planer transmission lines: Strip line, Microstrip Line, Coplanar line • Impedance Matching using lumped element and stub lines	06
2	RF Filter Design	• Filter Specifications • Filter design by insertion loss method	04
3	Waveguide and Waveguide Components	• Types of waveguides • Rectangular waveguide analysis: TE and TM Mode • Characteristics of TE and TM wave • Scattering parameters and its properties • Waveguide components: E and H plane tee, Magic tee, rat race circuit, directional coupler, ferrite devices, attenuators and phase shifters	06
4	Microwave Tubes	• Classification, fundamental principles, and significant applications of microwave vacuum tubes like two cavity klystron, reflex klystron, TWT and Magnetron	04
5	Noise and Microwave Solid State Devices	• Noise in microwave circuit: Dynamic range and source of noise, noise temperature, noise figure, intermodulation distortion, gain compression • Discussion on solid state devices such as Schottky diode, PIN diode, Varactor diode, Tunnel diode, Gunn diode and IMPATT diode	04
6	Introduction to RF Amplifier and Oscillator Design	• Introduction to two port gains, stability • Single stage transistor amplifier design for maximum gain • Design aspects of one port negative resistance oscillator	06
		Total	**30**

Textbooks:

1. David M. Pozar, "Microwave Engineering", John Wiley and Sons, 3rd Edition .
2. Sushrut Das, 'Microwave Engineering', Oxford University Press. 1st Edition .
3. Samuel Y. Liao, "Microwave Devices and Circuits",3rd Edition, Prentice Hall.
4. Guillermo Gonzalez, "Microwave Transistor Amplifiers: Analysis and Design", 2nd Edition, Prentice Hall.

Reference Books:

1. Robert E. Collin, "Foundations for Microwave Engineering", Second Edition, McGraw-Hill.
2. Matthew M. Radmanesh, "Radio Frequency and Microwave Electronics Illustrated" Prentice Hall.
3. George D. Vendelin, Anthony M. Pavio, and Ulrich L. Rohde, "Microwave Circuit Design: Using Linear and Nonlinear Techniques" 3rd Edition, John Wiley & Sons.

Course Name: RF and Microwave Engineering Lab

Course Code: PCET104P

Category: PC_PCC

Preamble:

The RF and Microwave Engineering Lab is designed to provide hands-on experience in the measurement, analysis, and design of high-frequency circuits and components. This lab course enables students to explore the practical aspects of RF and microwave engineering, including the behaviour of transmission lines, impedance matching, and the characterization of passive and active components.

Students will gain proficiency in using modern test and measurement equipment such as vector network analysers, spectrum analysers, and signal generators. They will also learn to use simulation tools for designing and analysing RF circuits. The lab emphasizes the development of practical skills necessary for careers in wireless communication, radar systems, satellite technology, and other high-frequency domains.

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Pre-requisites: RF and Microwave Engineering

Course Objectives:

This course familiarizes students with practical measurement techniques and modern simulation tools used in RF engineering. The objective of the RF and Microwave Engineering Lab is to provide students with practical knowledge and hands-on experience in the measurement, analysis, and design of high-frequency circuits and systems. The lab aims to reinforce theoretical concepts related to transmission lines, impedance matching, filters and RF/MW components, while developing proficiency in using modern RF test equipment and simulation tools.

Course Outcomes:

Students will be able to:

CO1: Design and implement impedance matching networks using lumped and distributed elements.

CO2: Design and implement microwave filter.

CO3: Apply simulation software tools to analyse and design RF and Microwave circuits.

CO4: Perform RF and Microwave measurements using laboratory equipment.

Course Scheme:

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

Assessment Scheme:

Head	ISA	MSA	ESA	Total
Practical	25	-	25	050

Suggested List of Practical:

List of problem statements for practical work. Make sure that practical is problem based. It should cover most of the course contents.

- Scattering parameters and its measurement
- Design and Analysis of matching circuit design using stubs
- Design and Analysis of matching circuit design using lumped element
- Filter design by insertion loss method
- Waveguide analysis using electromagnetic simulators.
- Characterization of planer circuit components like power divider, directional couplers etc.
- Experimentation of Gunn based test bench
- Experimentation of Klystron based test bench
- Class A amplifier design
- One port oscillator design

The above list is a mere suggestion. The course teacher may explore various ways to characterize RF/MW circuit performance. Suggested to refer course contents of theory course on 'RF and Microwave Engineering'.

Textbooks:

1. David M. Pozar, "Microwave Engineering", John Wiley and Sons, 3rd Edition .
2. Sushrut Das, 'Microwave Engineering', Oxford University Press. 1st Edition .
3. Samuel Y. Liao, "Microwave Devices and Circuits",3rd Edition, Prentice Hall.
4. Guillermo Gonzalez, "Microwave Transistor Amplifiers: Analysis and Design", 2nd Edition, Prentice Hall.

Reference Books:

1. Robert E. Collin, "Foundations for Microwave Engineering", Second Edition, McGraw-Hill.
2. Matthew M. Radmanesh, "Radio Frequency and Microwave Electronics Illustrated" Prentice Hall.
3. George D. Vendelin, Anthony M. Pavio, and Ulrich L. Rohde, "Microwave Circuit Design: Using Linear and Nonlinear Techniques" 3rd Edition, John Wiley & Sons.

Course Name: Telecommunication Network Management

Course Code: PEET21T

Category: PC_PEC

Name of the Track: Communication Engineering

Preamble:

This graduate course is an in-depth study of telecommunication network management technology and systems. Its focus is on the architecture, functions, methods and protocols necessary to design modern network management systems. Special emphasis is on network management standards such as Telecommunications Management Network (TMN) and Simple Network Management Protocol (SNMP.) Basic network management concepts and methods will be covered. Real-world examples will be used to illustrate concepts, protocols and methods that are fundamental to address network management issues.

Pre-requisites: Computer Networks.

Course Objectives:

1. To describe network management issues and the importance of network management standards in telecommunication networks.
2. To explore the Simple Network Management Protocol (SNMP).
3. To evaluate the Telecommunication Management Network (TMN).
4. To describe device management issues and standards.

Course Outcomes:

Students will be able to:

CO1: To describe network management issues and the importance of network management standards
in telecommunication networks
CO2: To describe fundamentals concepts and evaluate techniques of the Simple Network Management
Protocol (SNMP) and related standards
CO3: To evaluate the Telecommunication Management Network (TMN) standards of the International Telecommunications Union (ITU), and to describe fundamental concepts use in the standards, especially those of service management
CO4: To describe device management issues and standards

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	Introduction of Network Management	Overview of Data Communication and Network Management – Goals, Organization and Functions; Network Management – Architecture and Organization; Network Management Perpestives; Current Status and Future of Network Management. Network Topology, Network Node Components, Transmission Technology.	6
2	Internet Management	SNMP model: SNMP Organizational model, System overview, Information model, Management of Information Base, SNMP v1: SNMP Communication model- SNMP architecture, Administrative model, SNMP Protocol specifications, SNMP operations, SNMP Functional model SNMPv2: Major changes in SNMPv2, SNMPv2 architecture, SNMPv2 Management Information Base, SNMPv2 protocol, Compatibility with SNMPv1 SNMPv3:Key features, SNMPv3 architecture, SNMPv3 applications, Security, security model, message format, SNMPv3 User- based Security Model RMON: What is RMON? RMON 1, RMON 2	9
3	Telecommunication Management Networks (TMN)	Definition of TMN , TMN framework, TMN functional model TMN Conceptual model, OSI functionality in TMN TMN management services architecture and TMN implementation	3
4	Network Management Tools and Applications	NMS Design: Functional requirements, NMS Client design and NMS Server architecture, Distributed Management approaches. Network Management Systems: Commercial and Open-source NMSs. Network Management Applications: Fault, Configuration, Accounting, Performance and Security (FCAPS). Event Correlation Techniques, Report Management, Policy-based Management and Service Level Management	8

5	Web Based Management	Setting-UP LAN Access, SNMP configuration, Switched Port Analyzer, Web Browser /Web Server Communication	4
Total			**30**

Textbooks:

1. Mani Subramaniam, Network Management Principles and Practice, New Delhi: Pearson, 2010.
2. Alexander Clemm, Network Management Fundamentals, Cisco Press, December 2006, ISBN-13: 978-158720137.
3. Benoit Claise and Ralf Wolter, Network Management: Accounting and Performance Strategies, CISCO Press, 2007.
4. J. Richard Burke, Network Management: Concepts and Practice, A Hands-On Approach, Pearson Education India, 2008, ISBN-13: 978-8131718490.

Reference Books:

1. Stephen B.Morris, "Network management", MIBs and MPLS First Edition, Pearson Education, 2003.
2. Mark Burges "Principles of Network System Administration", Second Edition, Wiley, 2004.

Online Learning Resources:

1. https://www.youtube.com/watch?v=liBB_Q7Go5k
2. https://www.youtube.com/watch?v=xdUjwlyyi9U
3. https://www.youtube.com/watch?v=aQGeSDauRso
4. https://nptel.ac.in/courses/117/101/117101050/
5. https://nptel.ac.in/courses/106/105/10610

Course Name: Telecommunication Network Management Lab

Course Code: PEET21P

Category: Professional Elective

Name of the Track: Communication Engineering

Preamble:

This course is to provide students with an overview of the concepts and fundamentals of digital signal processing.

Pre-requisites:

Nil

Course Objectives:

1. To introduce networking commands.
2. To configure various networking devices in GNS3.
3. To monitor network using simulation tools.

Course Outcomes:

Learner will be able to:

CO1 Students will be able to simulate various telecommunication network management parameters.

CO2 Students will be able to design and validate various standards using software tool.

CO3 Students will be able to design and monitor telecommunication network management link and observe the various parameters using simulation tools.

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 Practical:

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

Sr No	Suggested Topic(s)
1	To know all the Networking Commands
2	Compiling program in ASN.1 compiler
3	To Study the SNMP messaging Commands
4	Development of SNMPv1 Management Information Base
5	Implementation of Static Routing with GNS3
6	How to configure router in GNS 3
7	Inter VLAN Configuration manageable switch in GNS3
8	Study of Remote Monitoring
9	GNS3 Packet Capture Using wireshark | Configure WIRESHARK in GNS3
10	Case study

Textbooks:

1. Mani Subramaniam, Network Management Principles and Practice, New Delhi: Pearson, 2010.
2. Alexander Clemm, Network Management Fundamentals, Cisco Press, December 2006,ISBN-13: 978-158720137.
3. Benoit Claise and Ralf Wolter, Network Management: Accounting and Performance Strategies, CISCO Press, 2007.
4. J. Richard Burke, Network Management: Concepts and Practice, A Hands-On Approach,Pearson Education India, 2008, ISBN-13: 978-8131718490.
5. Salh Aiidarons, Thomas Plevoyak, Telecommunications Network Technologies and Implementations, Eastern Economy Edition, New Delhi:IEEE Press, 1998.
6. Henry Haojin Wang, Telecommunication Network Management, McGraw Hill, 1999.

Course Name: Introduction to Data Analytics

Course Code: PEET27T

Category: PC_PEC

Name of the Track: Data Analytics and Machine Learning

Preamble:

This subject aims to provide a comprehensive introduction to the principles, techniques and tools used in data analytics. The course will combine theoretical usage of statistical methods with algorithm-based programming models to solve real-world data problems, enabling data driven decision making capabilities. The learners will develop the skills necessary to manipulate, visualize and analyze the data effectively.

Pre-requisites: Skill Labs (SEM-III)

Course Objectives:

- To understand the importance of data analytics in engineering applications.
- To study and interpret statistical terminologies used in data analysis operations.
- To gain proficiency in data wrangling, manipulation and preparation techniques.
- To perform exploratory data analysis through visualization.
- To develop predictive models and classification models using machine learning algorithms.
- To demonstrate ethical awareness and responsibility in data handling.

Course Outcomes:

Learner will be able to:

CO1: To understand Data Analytics Terminologies and visualize data patterns.
CO2: To apply statistical methods to get deeper significance of the data.
CO3: To utilize python programming skills for data cleansing operations.
CO4: To develop data prediction models using regression modelling.
CO5: To develop data classification and clustering models.

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 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 Data Analytics and EDA	Data Science Definitions: Volume, Variety, Veracity, Velocity, Machine Learning: Supervised & Unsupervised, Predictions and forecasts, Linear Algebra, Matrix Vectors and Calculus, fundamentals of data exploration, Exploratory Data Analysis (EDA) Python visualization libraries – Matplotlib, Seaborne, Numerical and categorical charting of data, chart data interpretation	6
2	Statistical Methods and Hypothesis Testing	Measures of Central Tendencies, Measures of Dispersion, Sample and Population concepts, Central Limit Theorem, Probability Distributions: Continuous and Discrete, Random Variables, Statistical Inference: Hypothesis Testing, significance of p value, Confidence Intervals, Type-I and Type-II errors, Z Tests, test for normality, Goodness of Fit Test, Contingency Tables, role of variance inflation factor	6
3	Data Preprocessing Techniques	Python Libraries: NumPy and PANDAS, data access, Boolean masking, filtering operation, group-by operation, multi-level indexing, Pivot and Melt functions, Matplotlib: main plots, summarizing numerical attributes, legends, titles, ticks and markers, sub-plotting, database concepts, connecting to and pulling data from databases, web page connections, API connections	6
4	Regression Modelling	Conditions for Regression and data assumptions, Simple Linear Regression, Multiple Linear Regression, Coefficient estimation, evaluation of regression models – R2, adjusted R2, Errors – RMSE, MAE, Multi collinearity checks, Variance Inflation factor analysis, Polynomial Regression, degrees of polynomial and its significance, Model underfitting, model overfitting, Bias and variance concepts and tradeoff mechanism.	6
5	Classification & Clustering models	Technical Requirements of classification, difference between classification and clustering operations, Logistic Regression, Naïve Bayes, KNN algorithm, Decision Trees, Random Forests, Support Vector Machines, K means clustering, Dimensionality Reduction using Principle Component Analysis (PCA)	6
Total			**30**

Textbooks:

1. Handon Data Preprocessing in Python by Roy Jafari, Packt Publication, January 2022.
2. Machine Learning with Python: Theory and Implementation by Amin Zollanvari, Springer.
3. Practical Statistics for Data Scientists by Peter Bruce, Andrew Bruce, Oreilly Publication.

Reference Books:

1. Practical Machine Learning with Python by Dipanjan Sarkar, Raghav Bali & Tushar Sharma, Apress Publications, India.
2. Python Data Analytics by Fabio Nelli, Apress Publications.
3. Introduction to Python for Computer Science and Data Science by Paul Deitel and Harvey Deitel, Deitel Series.

Course Name: Introduction to Data Analytics Lab

Course Code: PEET27P

Category: PC_PEC

Name of the Track: Data Analytics and Machine Learning

Preamble:

This lab course provides a hands-on experience to enable the learner to gain proficiency in Python data wrangling operation, visualizing techniques to reveal the data pattern. The learner will be introduced to predict and classify the real time data applications using statistical techniques and algorithms based on regression modelling, classification and clustering principles.

Pre-requisites: Python Programming (SEM-III) (Skill Lab)

Course Objectives:

- To perform exploratory data analysis to reveal the data pattern
- To evaluate statistical metrics for preprocessing of data sets
- To perform data cleaning operations to prepare data for modelling
- To develop prediction models using regression principles
- To develop classification and clustering models

Course Outcomes:

Learner will be able to:

CO1: Study the data set and explore the patterns using EDA techniques
CO2: Estimate statistical parameters and metrics for the given data set
CO3: Perform data cleaning tasks to prepare data for analysis operations
CO4: Create prediction models using regression techniques
CO5: Create classification and clustering models

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:

Sr. No.	List of experiments
1	Explore the data using EDA techniques – Numerical and categorical data visualization through various plots
2	Data Normality Inspection, data distribution and verification of central limit theorem
3	Data Manipulation using different functions with NumPy and PANDAS libraries
4	Data Manipulation using special functions Pivot and Melt
5	Hypothesis Testing Methods
6	Data Cleaning: Missing values, Null values, scaling and normalization
7	Data Combining Techniques: Groupby, Join, Merge techniques
8	Regression Modelling – Simple Linear Regression, Multiple Linear Regression
9	Regression Modelling – Polynomial Regression, Logistic Regression
10	Classification Models – KNN, Random Forests, SVM
11	Clustering Techniques – Naïve Bayes, K means clustering
12	Principle Component Analysis

Textbooks:

1. Handon Data Preprocessing in Python by Roy Jafari, Packt Publication, January 2022.
2. Machine Learning with Python: Theory and Implementation by Amin Zollanvari, Springer.
3. Practical Statistics for Data Scientists by Peter Bruce, Andrew Bruce, Oreilly Publication.

Reference Books:

1. Practical Machine Learning with Python by Dipanjan Sarkar, Raghav Bali & Tushar Sharma, Apress Publications, India.
2. Python Data Analytics by Fabio Nelli, Apress Publications.
3. Introduction to Python for Computer Science and Data Science by Paul Deitel and Harvey Deitel, Deitel Series.

Course Name: Principles of Internet of Things

Course Code: PEET33T

Category: PC_PEC

Name of the Track: Internet of Things

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 analyse 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	Definition and characteristics of IoT, History and evolution of IoT, Architectural layers of an IoT system (perception, network, application, data management), Levels of IoT	5
2	Communication Protocols	IoT Edge to Cloud protocols: HTTP, REST APIs, WebSocket, MQTT, COAP, Comparison of Protocols.M2M Communication Protocols, Bluetooth BR/EDR and Bluetooth low energy. RFID IoT System, RFID IoT Network Architecture, ZigBee IP/ZigBee SE2.0, Wifi(WLAN), Message Communication protocols for connected devices Data exchange formats: JSON & XML	5
3	Sensor Interfaces	Digital Interfaces: UART, Serial Peripheral Interface (SPI), I2C (Inter-Integrated Circuit), Controller Area Network (CAN), Middleware Technologies, Communication Protocols and Models. Practical Components Programming with interface in Arduino, MBed and Raspberry Pi	5
4	Hardware Fundamentals	Introduction to various sensors (temperature, humidity, pressure, motion, etc.) Actuators and their types (solenoids, motors, relays) Microcontrollers and development boards (e.g., Arduino, Raspberry Pi) Interfacing sensors and actuators with microcontrollers Introduction to embedded system design principles	5
5	Software Development for IoT	Introduction to programming languages for IoT (e.g., Python, C++) Data acquisition, processing, and visualization techniques, 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. Arshdeep Bahga 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 Laboratory

Course Code: PEET33P

Category: PC_PEC

Name of the Track: Internet of Things

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:

Microprocessor & Microcontroller (ET05)

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:

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 thingspeak, thingsboard, 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: Advanced VLSI Design and Technology

Course Code: PEET39T

Category: PC_PEC

Name of the Track: Very Large Scale Integration

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	4^{th}	1
2	CMOS VLSI Design: A Circuits and Systems	Neil H. E. Weste, David Harris and Ayan Banerjee,	Pearson Education	5^{th}	1,2

	Perspective				
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: PEET39P

Category: PC_PEC

Name of the Track: Very Large Scale Integration

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: Tracking System

Course Code: PEET22T

Category: PC_PEC

Preamble:

This course introduces students to the tracking systems as fundamental principles of radar systems, and radar range. In the tracking system different types of Radar Systems, different types of navigational aids used and the basic design of radar transmitter and receiver. In this various detection techniques used for the detection and tracking objects, and practical applications of tracking systems.

Pre-requisites:

Principles of communication Engineering

Course Objectives:

- To know a basic radar system, its related concepts and applications.
- To Learn various forms of radar equations to determine the range.
- To Understand the types of radars such as CW, MTI and pulse radar.
- To Learn tracing radar, detection of radar signals in noise and radar receivers.

Course Outcomes:

Student will be able to:

CO1: understand the radar system and its applications.
CO2: determine range of a radar using various forms of radar equations.
CO3: Understand different types of radar systems functioning.
CO4: understand different type of tracking methods for radar systems.
CO5: understand radar receiver systems.

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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.	Module Name	Content	No. of Hours
1	Introduction to Tracking System	Introduction to Radar system, Maximum Unambiguous Range, Radar Block Diagram and Operation, Radar Waveforms, Simple form of Radar Equation, Radar Frequencies and Applications.	5
2	Range Analysis	Prediction of Range Performance, Minimum Detectable Signal, Receiver Noise and SNR, Integration of Radar Pulses, Radar Cross Section of Targets (simple targets - sphere, cone-sphere), Transmitter Power, PRF and Range Ambiguities, Envelope Detector - False Alarm Time and Probability, Probability of Detection, System Losses (qualitative treatment). Radar Clutters: Surface clutter radar equations, sea clutter, land clutter, effects of weather on radar, angles echoes.	7
3	CW, MTI and Pulse Doppler Radar systems	Doppler Effect, CW Radar – Block Diagram, Isolation between Transmitter and Receiver, Non-zero IF Receiver, Receiver Bandwidth Requirements, Applications of CW radar. FM-CW Radar, Range and Doppler Measurement, MTI Radar with - Power Amplifier Transmitter and Power oscillator Transmitter, Delay Line Cancellers – Filter Characteristics, Blind Speeds, Double Cancellation, Staggered PRFs. Range Gated Doppler Filters. MTI Radar Parameters, Limitations to MTI Performance. Non-coherent MTI, MTI versus Pulse Doppler Radar.	8
4	Tracking Methods	Tracking with Radar, Sequential Lobing, Conical Scan, Monopulse Tracking Radar – Amplitude Comparison Monopulse (one- and two- coordinates), Phase Comparison Monopulse. Target Reflection Characteristics and Angular Accuracy. Tracking in Range, Acquisition and Scanning Patterns. Comparison of Trackers.	5
5	Radar Receivers	Noise Figure and Noise Temperature. Displays – types. Duplexers –Branch type and Balanced type, Circulators as Duplexers. Introduction to Phased Array Antennas – Basic Concepts, Radiation Pattern, Beam Steering and Beam Width changes, Series versus Parallel Feeds, Applications, Advantages and Limitations	5
Total			**30**

Textbooks:

1. Introduction to radar system, M. I. Skolnik, TMH edition, 2007.
2. Radar Principles, Peyton Peebles, Wiley publication 2004.

Reference Books:

1. Radar Design Principles, Fred E. Nathanson, PHI
2. Principles of Modem Radar: Basic Principles-Mark A. Rkhards, James A. Scheer, William.A. Holm.Yesdee, 2013
3. Radar Engineering, GSN Raju, IK International.

Course Name: Tracking System Lab

Course Code: PEET22P

Category: PC_PEC

Preamble:

This course introduces students to the analysis of tracking systems fundamental principles such as pulse repetition time, pulse repetition frequencies, radar range analysis using experimentation with the help of simulation tools. Analysis of different types of radar systems for various requirements and environments. Analysis of targets based on its size and shape at various frequencies. Probabilistic analysis of detection of targets.

Pre-requisites:

Principles of communication Engineering

Course Objectives:

- To analyse basic concepts of radar systems as pulse repetition frequency and time.
- To determine radar range using various forms of radar equations.
- To understand different types of radars for various requirements and environments.
- To Analyse objects based on its size and shape.
- To analyse detection of targets.

Course Outcomes:

Student will be able to:

CO1: Analyze fundamental principles of tracking systems.
CO2: Determine radar system range in various conditions.
CO3: Understand different types of radar systems functioning.
CO4: Analyze different types of objects.
CO5: Analysis of detection of targets using probability concepts.
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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:

- Determination of maximum unambiguous range.
- Analysis of pulse repetition frequency and pulse repetition time for radar systems.
- Analysis of radar range for various environments and conditions.
- Analysis of CW radar system.
- Analysis of MTI radar system.
- Calculations of radar cross sections and its analysis.
- Probabilistic analysis of target detections.
- Tracking system receiver performance analysis.
- Estimation of blind speed effect on the Radar performance.

Text Books:

1. Introduction to radar system, M. I. Skolnik, TMH edition, 2007.
2. Radar Principles, Peyton Peebles, Wiley publication 2004.

Reference Books:

1. Radar Design Principles, Fred E. Nathanson, PHI
2. Principles of Modem Radar: Basic Principles-Mark A. Rkhards, James A. Scheer, William.A. Holm.Yesdee, 2013
3. Radar Engineering, GSN Raju, IK International.

Course Name: Machine Learning

Course Code: PEET28T

Category: PC_PEC

Track Name: Data Analytics and Machine Learning

Preamble:
This course aims to provide the necessary mathematical background to understand the development of supervised and unsupervised machine learning algorithms. Learners will be introduced to machine learning algorithms including regression, classification and clustering tasks.

Pre-requisites:

Nil

Course Objectives:

- To understand the mathematical terminologies, probability and linear algebra used in ML algorithms.
- To apply Python programming skills for data cleansing operations.
- To create Regression models for target variable prediction tasks in machine learning.
- To create Classification models for target variable classification tasks in machine learning.
- To create Clustering models for unsupervised Machine Learning applications

Course Outcomes:

Student will be able to:

CO1: Understand the various probability and linear algebra usage for foundation of Machine Learning
CO2: Apply Python Programming structures for data cleaning operations

CO3: Create Regression ML models for target variable estimation operation

CO4: Create Classification ML models for target variable classification purpose

CO5: Create Clustering models for unsupervised ML applications

Course Scheme:

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

Assessment Guidelines:

Head	ISA	MSA	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	Mathematical Foundations for ML	Definition and importance of Machine Learning, Applications of Machine Learning and types: Supervised and Unsupervised types, Basics of Linear Algebra: Vectors, Matrices, Vector Spaces, Eigen Values, Eigen Vectors, Probability and statistics: Probability distributions-continuous and discrete, Conditional Probability, Baye's theorem, Expectation, variance, Central limit theorem	5
2	Data Preprocessing	Introduction to Data Preprocessing, Importance of Data Preprocessing, Data Cleaning operations – Handling missing values, removing duplicate data, handling outliers, Data Normalization and standardization techniques and its necessity, visualizing data distributions, correlation between variables, merging datasets, concatenating datasets, Data manipulation using Pandas	5
3	Feature Engineering	Imbalanced Data Handling, oversampling, under sampling, multicollinearity principle, concepts of bias and variance in datasets, variable selection (feature selection), Categorical encoding (label encoding, one-hot encoding), scaling of numerical data Principal Component Analysis technique (feature extraction)	5
4	Supervised Learning	Concept of supervised Machine Learning, supervised learning problems: Classification verses Regression, Linear Regression: Simple Linear Regression, Evaluation of model performance: RMSE, R-squared, Classification algorithms: Logistic Regression, k-Nearest Neighbours (kNN), Naïve Bayes Classifier, Decision Tree Classifier and Regressor, Support Vector Machines for classification and regression (only introduction), confusion matrix, precision, recall and F1-score	8
5	Unsupervised Learning	Concept of Unsupervised Machine learning, difference between supervised and unsupervised machine learning, Clustering Algorithms – K means clustering, applications and limitations, Density based clustering – DBSCAN algorithm	7
Total			**30**

Textbooks:

1. Introduction to Probability and Statistics for Engineers and Scientists, 5th Edition, Sheldon M Ross, Elsevier Publication
2. Handson Data Preprocessing in Python: Roy Jafari, Packt Publication, 2022
3. Machine Learning with Python: Theory & Implementation, Amin Zollanvari, Springer Publications

Reference Books:

1. Practical Machine Learning with Python, Sarkar Bali & Sharma, Apress Publication
2. Introduction to Machine Learning with Python, Andreas C. Muller, Sarah Guido, Oreilly Publication

Course Name: Machine Learning Lab

Course Code: PEET28P

Category: PC_PEC

Track Name: Data Analytics and Machine Learning

Preamble:

This course aims to provide the necessary mathematical background to understand the development of supervised and unsupervised machine learning algorithms. Learners will be introduced to machine learning algorithms including regression, classification and clustering tasks.

Pre-requisites:

Nil

Course Objectives:

- To develop ML algorithm using Supervised learning approach
- To develop ML algorithm using unsupervised learning approach
- Creating labelled supervised data model with clustering approach
- To create hyper parameter tuning model for performance comparison different models
- To evaluate model performances using different statical metrics

Course Outcomes:

Student will be able to:

CO1: Apply supervised ML algorithm for prediction / estimation of target variable (regression)
CO2: Apply supervised ML algorithm for classification of target variable (classification)
CO3: Apply unsupervised ML algorithm for prediction / estimation of target variable (regression)
CO4: Apply unsupervised ML algorithm for classification of target variable (classification)
CO5: Apply segmentation technique using Clustering operation

Course Scheme:

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

Assessment Scheme:

Head	ISA	MSA	ESA	Total
Practical	25	-	25	50

Suggested List of Practical:

Note – The student must have prior sound knowledge of related mathematics and statistics and Python Programming (including handling libraries like NumPy, Pandas, Matplotlib, Seaborne, SciPy, ScikitLearn etc.) Laboratory session will comprise of three distinct methodologies:

1. Design of ML algorithm using Supervised algorithm for regression estimation
2. Design of ML algorithm using Supervised algorithm for classification
3. Design of ML algorithm using unsupervised algorithm for regression estimation
4. Design of ML algorithm using unsupervised algorithm for classification
5. Dimensionality reduction technique using Principal Component Analysis
6. Segmentation / clustering algorithm
7. Feature engineering operation – feature selection, feature extraction
8. Hyper Parameter tuning for different ML algorithms

Textbooks:

1. Introduction to Probability and Statistics for Engineers and Scientists, 5th Edition, Sheldon M Ross, Elsevier Publication
2. Handson Data Preprocessing in Python: Roy Jafari, Packt Publication, 2022
3. Machine Learning with Python: Theory & Implementation, Amin Zollanvari, Springer Publications

Reference Books:

1. Practical Machine Learning with Python, Sarkar Bali & Sharma, Apress Publication
2. Introduction to Machine Learning with Python, Andreas C. Muller, Sarah Guido, Oreilly Publication

Course Name: Embedded System Design with Tiny Operating System

Course Code: PEET34T

Category: PC_PEC

Name of the Track: Internet of Things

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 blends the concepts of embedded systems with machine learning for developing smart and dedicated applications for requirements of IoT.

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	-

Assessment Guidelines:

Head	ISA	MSA	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	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, process synchronization with algorithms, threading	6
5	Tiny machine Learning Fundamentals	Concept of machine learning, fundamentals of tiny ML, design and challenges	3
6	Tiny machine Learning Implementation	Getting started with tiny ML, implementation of ML algorithms	4
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

Course Name: Embedded System Design with Tiny Operating System Laboratory

Course Code: PEET34P

Category: 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 enables learner to use concept of tiny machine learning 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	MSA	ESA	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

Course Name: Analog IC Design

Course Code: PEET40T

Category: 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: PEET40P

Category: PC_PEC

Name of the Track: Very Large Scale Integration

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: Engineering Economics

Course Code: EEMC03

Category: HSSM_EEMC

Preamble:

The course focuses on economic and cost analysis of engineering projects, giving insights on modern techniques and methods used on economic feasibility studies relating to design and implementation of engineering projects. The basic purpose of this course is to provide a sound understanding of concepts and principles of engineering economy and to develop proficiency with methods for making rational decisions regarding problems likely to be encountered in professional practice.

Pre-requisites:

Nil

Course Objectives:

The course introduces concepts and economic analysis procedures to assist with decision making in engineering analysis. Concepts include Time value of money and cash flow diagrams; simple, compound, nominal, and effective interest rate; single and series payments. Methods to compare project alternatives include present, future, and annual worth, and rate of return analysis.

Course Outcomes:

Learners will be able to:

CO1: Understand and apply fundamental concepts and use of terminology of engineering economics.
CO2: Derive and use the engineering economy factors to account for the time value of money.
CO3: Use multiple factors to find equivalent amounts for cash flows that have nonstandard placement.
CO4: Utilize Present, Future Worth Analysis and Annual Worth Analysis techniques to evaluate and select alternatives.

Course Scheme:

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

Assessment Guidelines:

Head	ISA	MSA	ESA	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	Introduction to Engineering Economics	Origin of Engineering Economy, Principles of Engineering Economy, Role of Engineers in Decision Making, Cash Flow Diagram.	3
2	Interest and Time Value of Money	Introduction to Time Value of Money, Simple Interest, Compound Interest, Nominal Interest rate, Effective Interest rate, Continuous Compounding, Economic Equivalence, Development of Interest Formulas, The Five Types of Cash flows, Single Cash flow Formulas, Uneven Payment Series, Equal Payment Series, Linear Gradient Series, Geometric Gradient Series.	6
3	Basic Methodologies of Engineering Economic Analysis	Determining Minimum Attractive (Acceptable) Rate of Return (MARR), Payback Period Method, Equivalent Worth Methods, Present Worth Method, Future Worth Method, Annual Worth Method, Rate of Return Methods, Internal Rate of Return Method, External/Modified Rate of Return Method., Public Sector Economic Analysis (Benefit Cost Ratio Method), Introduction to Lifecycle Costing, Introduction to Financial and Economic Analysis	6
4	Comparative Analysis of Alternatives	Comparing Mutually Exclusive Alternatives having Same useful life by, Payback Period Method and Equivalent Worth Method, Rate of Return Methods and Benefit Cost Ratio Method, Comparing Mutually Exclusive Alternatives having different useful lives by, Repeatability Assumption, Co-terminated Assumption, Capitalized Worth Method, Comparing Mutually Exclusive, Contingent and Independent Projects in Combination.	6
5	Replacement Analysis	Fundamentals of Replacement Analysis, Basic Concepts and Terminology, Approaches for Comparing Defender and Challenger, Economic Service Life of Challenger and Defender, Replacement Analysis When Required Service Life is Long, Required Assumptions and Decision Framework, Replacement Analysis under the Infinite Planning Horizon, Replacement Analysis under the Finite Planning Horizon	6
6	Risk Analysis	Origin/Sources of Project Risks, Methods of Describing Project Risks, Sensitivity Analysis, Breakeven Analysis, Scenario Analysis, Probability Concept of Economic Analysis, Decision Tree and Sequential Investment Decisions	3
Total			**30**

Textbooks:

1. Chan S. Park, Contemporary Engineering Economics, Prentice Hall, Inc.
2. E. Paul De Garmo, William G. Sullivan and James A. Bonta delli,Engineering Economy, MC Milan Publishing Company.
3. James L. Riggs, David D. Bedworth and Sabah U. Randhawa,Engineering Economics, Tata MCGraw Hill Education Private Limited. .

Reference Books:

1. Ahuja H. L" Micro Economic Theory" S. Chand Publication, New Delhi
2. Dewett K. K "Modern Economic Theory" S. Chand Publication, New Delhi
3. Jain T. R. Grover M. L. Ohri V. K Khanna O. P," Economics for engineers" V. K. Publication, New Delhi

Detailed syllabus of Third Year Semester – VI
Multidisciplinary Minor (MDM)

Course Name: Financial Basics for Engineers and Technopreneurs

Course Code: MDMBD02

Category: 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	Tutorial	Theory	Tutorial
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 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**

PO Mapping by Module:

- Module 1: PO11, PO1
- Module 2: PO4, PO11
- Module 3: PO2, PO11
- Module 4: PO1, PO4
- Module 5: PO6, PO11
- Module 6: PO11, PO12

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: Algorithms and Data Structures in Bioinformatics

Course Code: MDMBI02

Category: 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

Pre-requisite: Introduction to Bioinformatics

Course Objectives:

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

Course Outcomes:

Learner will be able to:

Course Outcome	Course Outcome Statement	Bloom's Level
CO1	Apply fundamental data structures and algorithms (arrays, trees, graphs, hashing, etc.) to solve computational problems in bioinformatics.	Apply
CO2	Analyze and implement sequence alignment algorithms for comparing DNA, RNA, and protein sequences, including global, local, and heuristic approaches.	Analyse
CO3	Construct and interpret phylogenetic trees using distance-based and character-based algorithms for evolutionary analysis.	Applying
CO4	Use algorithmic and statistical models, such as HMMs and motif-finding tools, to predict genes and regulatory elements in genomic sequences.	Applying
CO5	Design and evaluate scalable bioinformatics workflows and pipelines using big data technologies and cloud platforms for handling large-scale genomic datasets.	Evaluate

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Tutorial	Theory	Tutorial
3	1	3	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	45	30	80	125

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	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
2	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	10
3	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	10
4	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	10
5	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	7
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 : Startup Planning and Development

Course Code: MDMIE02

Category: MDM

Preamble:

This course is designed with the objective of equipping students with understanding of s Startup Planning and Development

Pre-requisite: Foundations of Innovation and Entrepreneurship

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:

Learner 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:

Course Code	Contact Hours		Credits Assigned	
	Theory	Tutorial	Theory	Tutorial
MDMBI02	3	1	3	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	45	30	80	125

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	9
2	Market Research and Strategy	• TAM-SAM-SOM analysis • Competitive analysis • Go-to-market strategy	9
3	Startup Finance	• Basics of financial modelling • Unit economics, pricing, and revenue models • Funding sources: bootstrapping, angels, VCs, crowdfunding	9
4	Legal & Regulatory Aspects	• Company formation: types and registration • IPR basics: patents, trademarks, copyrights • Compliance and taxation	9
5	Business Plan Development	• Writing an effective business plan • Pitch deck essentials	9
Total			45

Tutorials:

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

Textbook and Resources

1. Zero to One by Peter Thiel
2. The Lean Startup by Eric Ries
3. Venture Deals by Brad Feld

Course: Machine Vision and Robotic Perception

Course: MDMRB02

Category: 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=0AAAACbv-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

Course Name: Operating Systems and Computer Networks

Course Code: MDMCS02

Category: MDM

Preamble:

This course introduces the basics of Operating Systems and intermediate concepts in Computer Networks, focusing on how systems manage processes and enable communication. Students will learn key OS functions, networking protocols, and explore their integration through hands-on tasks like scheduling, subnetting, and socket programming. The course emphasizes real-world relevance in areas like virtualization, cloud computing, and secure communications.

Pre-requisites:

3. ES04T (Structured Programming)
4. ES04T (Object Oriented Programming)

Course Objectives:

- To establish foundational understanding of operating system principles, including process management, memory management, and system-level functionalities, enabling students to recall and apply these concepts in computing tasks.
- To develop conceptual clarity of computer networking fundamentals such as layered architectures, addressing schemes, protocols, and network models to support effective communication between systems.
- To build practical skills in configuring networks, analysing traffic using tools, and simulating OS-level tasks like scheduling and memory allocation for system efficiency.
- To apply integrated knowledge of operating systems and computer networks in designing and implementing basic client-server applications and exploring modern environments like cloud and containerized systems.

Course Outcomes:

Learners will be able to

CO1: Recall fundamental concepts of operating systems such as process states, memory management techniques, and system calls.
CO2: Explain core principles of computer networks including OSI and TCP/IP models, IP addressing, and transport layer protocols.
CO3: Describe the interaction between operating systems and network components for enabling process communication and data transfer.
CO4: Implement basic OS-level algorithms such as process scheduling and memory allocation and simulate network operations using tools.
CO5: Analyse the performance of OS and network mechanisms with respect to efficiency, scalability, and resource utilization.
CO6: Evaluate the role of OS and networking integration in solving real-world problems such as secure communication, client-server architecture, and containerized deployment.

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 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 Operating Systems	Overview of Operating Systems, types of OS (batch, multitasking, real-time), components (kernel, shell), system calls, functions and services of OS, booting process.	6
2	Process and Memory Management	Process concepts, process states, scheduling algorithms (FCFS, SJF, Round Robin), memory management basics, paging and segmentation (conceptual).	6
3	Network Fundamentals	OSI and TCP/IP models, data encapsulation, IP addressing (IPv4 basics), subnetting, MAC address, ARP, DHCP, DNS, routing and switching fundamentals.	12
4	Transport and Application Layer Protocols	TCP vs UDP, 3-way handshake, flow and congestion control, protocols: HTTP, FTP, SMTP, HTTPS. Use of port numbers, socket basics.	8
5	Wireless Networking and Security	Wireless networks (WLAN, Bluetooth, 5G basics), VPN, firewalls, basics of encryption (symmetric vs. asymmetric), SSL/TLS, secure browsing practices.	7
6	OS-Network Integration & Application	Role of OS in networking: sockets, inter-process communication, threads with network programming, introduction to container networking (Docker), client-server applications.	6
Total			**45**

Text Books:

1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Operating System Concepts, 10th Edition, Wiley, ISBN: 978-1119456339
2. Andrew S. Tanenbaum, Herbert Bos, Modern Operating Systems, 4th Edition, Pearson, ISBN: 978-0133591620
3. Behrouz A. Forouzan, Data Communications and Networking, 5th Edition, McGraw-Hill, ISBN: 978-0073376226
4. James F. Kurose, Keith W. Ross, Computer Networking: A Top-Down Approach, 7th Edition, Pearson, ISBN: 978-0136681557
5. William Stallings, Operating Systems: Internals and Design Principles, 9th Edition, Pearson, ISBN: 978-0134670959

Reference Books:

1. William Stallings, Data and Computer Communications, 10th Edition, Pearson, ISBN: 978-0133506488
2. Daniel P. Bovet, Marco Cesati, Understanding the Linux Kernel, 3rd Edition, O'Reilly Media, ISBN: 978-0596005658
3. Douglas E. Comer, Computer Networks and Internets, 6th Edition, Pearson, ISBN: 978-0133587937
4. Tanenbaum and Steen, Distributed Systems: Principles and Paradigms, 2nd Edition, Pearson, ISBN: 978-8131734031
5. Thomas L. Floyd, Network Fundamentals, Pearson Education, ISBN: 978-0131973831