

As Per NEP 2020

University of Mumbai



Syllabus for Major Vertical – 1, 4 & 5

Name of the Programme – B.E. (Electronics & Telecommunication)

Faulty of Engineering

Board of Studies in Electronics & Telecommunication

U.G. Third Year Programme

Exit
Degree

B.Sc. Tech Engineering-
Electronics &
Telecommunication.

Semester

V & VI

From the Academic Year

2026-27

University of Mumbai



(As per NEP 2020)

Sr. No.	Heading	Particulars
1	Title of program O: _____	B.E. (<u>Electronics & Telecommunication</u>)
2	Exit Degree	B.Sc. Tech Engineering (<u>Electronics & Telecommunication</u>).
3	Scheme of Examination R: _____	NEP 40% Internal 60% External, Semester End Examination Individual Passing in Internal and External Examination
4	Standards of Passing R: _____	40%
5	Credit Structure R: _____	Attached herewith
6	Semesters	Sem. V & VI
7	Program Academic Level	5.5
8	Pattern	Semester
9	Status	New
10	To be implemented from Academic Year	2026-27

Sd/-
Dr. Faruk Kazi
BoS-Chairman- Electronics and
Telecommunication Engineering
Faculty of Technology

Sd/-
Dr. Deven Shah
Associate Dean
Faculty of Science & Technology

Sd/-
Prof. Shivram S. Garje
Dean
Faculty of Science & Technology

Preamble

To meet the challenge of ensuring excellence and alignment with the NEP 2020 policy in engineering education, the issue of quality needs to be addressed, debated, and taken forward systematically. Accreditation is one of the principal means of quality assurance in higher education. The major emphasis of the accreditation process is to measure the outcomes of the program being accredited. In line with this, the Faculty of Science and Technology (in particular Engineering) of the University of Mumbai has taken the lead in incorporating the philosophy of NEP 2020 in the process of curriculum development.

The Third Year Engineering curriculum consists of core and elective courses designed to impart scientific temper, logical thinking, and professional competency to learners, along with opportunities for course selection from Program Core Courses, Program Elective Courses, Multidisciplinary Minor (MDM), Indian Knowledge System (IKS), Professional Communication and Ethics (PCE), and Vocational Skill Enhancement Courses. Simultaneously, the objectives of NEP 2020 emphasize nurturing domain knowledge, communication skills, interdisciplinary exposure, and professional competencies required for the Electronics and Telecommunication Engineering (EXTC) branch in the learner.

Keeping this in view, a pool of courses is offered under Core Courses covering the fundamentals required to understand conventional and modern engineering practices, along with emerging technological trends. Elective courses are offered to enable learners to explore emerging technologies and interdisciplinary applications. This will contribute to the holistic development of learners through interdisciplinary skill development and mobility across departments for solving real-world engineering problems. Considering the shift in pedagogy and the need for a stress-free learning environment, a choice-based subject pool is offered under the heads of open electives and multidisciplinary minor courses in Semesters V and VI. Further, vocational and skill enhancement courses are introduced to provide learners with exposure to current industrial practices and to nurture creativity, innovation, and professional skills. The curriculum structure thus provides learners the flexibility and opportunity to choose courses of their interest across disciplines.

Program Core Courses and Program Elective Courses cover the core and advanced areas of Electronics and Telecommunication Engineering. In addition, a pool of subjects is offered under the Multidisciplinary Minor (MDM) framework for learner selection. Learners will also undertake IKS and PCE courses. Considering the present technological scenario, diverse choices are made available to fulfil learners' aspirations for careers in emerging technologies and interdisciplinary research domains. The IKS course, being program-specific, aims to provide learners with an objective perspective of the evolution of technology, its foundations, and its applications, thereby transforming learners from rote learners into creative professionals. The PCE course is introduced to strengthen communication skills and professional ethics, enabling learners to become competent professionals for placements and higher education opportunities.

Considering the NEP 2020 framework, which provides for multiple exit options such as Certificate after the First Year, Diploma after the Second Year, and B.Sc. (Tech.) Engineering after the Third Year, vocational skill-based course pools are incorporated to provide exposure to current industry practices and enhance employability.

The faculty resolved that Course Objectives and Course Outcomes are to be clearly defined for every core and elective course so that faculty members in affiliated institutes understand the depth and approach of the curriculum to be taught, thereby enhancing the overall teaching-learning process. The NEP 2020 grading system enables a much-needed shift from teacher-centric education to learner-centric education, where the workload is estimated based on the learner's investment of time in learning rather than only on teaching hours. It also focuses on the holistic development of learners through flexibility, mobility, and continuous evaluation, thereby enhancing the quality of education. Credit assignment for courses is based on a 15-week teaching-learning process as per NEP 2020 guidelines. However, the syllabus content is expected to be completed in 12–13 weeks, while the remaining 2–3 weeks may be utilized for revision, self-learning, tutorials, guest lectures, and coverage of advanced topics beyond the syllabus.

There was a concern that the Third Year syllabus should not be heavily loaded and that learners entering the Third Year of Engineering should feel comfortable with the academic structure by reducing unnecessary burden in terms of syllabus and credits. This is necessary for learners to adapt to the new academic environment and to foster a healthy and interactive bond between teachers and learners. The present curriculum will be implemented for the Third Year of Engineering from the Academic Year 2026–27. Subsequently, the system will be extended to the Final Year Engineering curriculum from the Academic Year 2027–28.

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B.Sc. Tech Engineering (Electronics & Telecommunication).

Credit Structure (Sem. V & VI)

	R: _____C									
Level	Semester	Major		Minor	OE	VSC, SEC (VSEC)	AEC, VEC, IKS	OJT, FP, CEP, CC,RP	Cum. Cr. / Sem.	Degree/ Cum. Cr.
		Mandatory	Electives							
5.5	V	PCC501:3 PCC502:3 PCC503:3 PCL501: 1 PCL502:1 PCL503:1	PEC501:3 PEL501:1	MDC:3 MDL:1	OE:2	--	IKS: 2	—	24	B.Sc. Tech Engineering (Electronics & Telecommuni- cation) 48
	R: _____D									
	VI	PCC601:3 PCC602:3 PCL601:1 PCL602:1	PEC601:3 PEC602:3 PEL601:1 PEL602:1	MDC: 3 MDL:1	—	VSEC:2	AEC: 2	--	24	
	Cum Cr.	20	12	8	2	2	2+2	--	48	

Exit option: Award of BSc. Tech Engineering with 138 credits and additional 4 credits core **one** theory subject with 3 credits and **one** lab with 1 credit from one final year from where they want to take Exit degree. Along with theory and practical course student must compulsory do internship for **one month or 160 hours** which internship is equal to 4 credits.

[Abbreviation - OE – Open Electives, VSC – Vocation Skill Course, SEC – Skill Enhancement Course, (VSEC), AEC – Ability Enhancement Course, VEC – Value Education Course, IKS – Indian Knowledge System, OJT – on Job Training, FP – Field Project, CEP – Continuing Education Program, CC – Co-Curricular, RP – Research Project]

T.E. Electronics & Telecommunication

Scheme

TE EXTC Vert-1 Syllabus 2016-05-2026 Light

Program Structure for Third Year of Electronics & Telecommunication
UNIVERSITY OF MUMBAI (With Effect from 2026-2027)

SEMESTER V

Course Code	Course Description	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Practical	Tutorial	Theory	Tutorial	Practical	Total Credits
PCC501	Computer Communication Networks	3	--	--	3	--	--	3
PCC502	Electromagnetics and Antenna	3	--	--	3	--	--	3
PCC503	Discrete Time Signal Processing	3	--	--	3	--	--	3
PEC501	PEC-1	3	--	--	3	--	--	3
MDC501	Multidisciplinary Minor	3	--	--	3	--	--	3
PCL501	Communication Networks Laboratory	--	2	--	--	--	1	1
PCL502	Electromagnetics and Antenna Laboratory	--	2	--	--	--	1	1
PCL503	Discrete Time Signal Processing Laboratory	--	2	--	--	--	1	1
PEL501	PEL-1	--	2	--	--	--	1	1
MDL501	Multidisciplinary Minor Laboratory	--	2@	--	--	--	1	1
OECL501	To be taken from the bucket provided by the University from other Faculty	2#	--	--	2	--	--	2
IKS501	IKS as per Groups	--	2*+2	--	--	--	2	2
Total		17	14	00	17	00	07	24

* Two hours of practical class to be conducted for full class as demo/discussion.

Theory / Tutorial 1 credit for 1 hour and Practical 1 credit for 2 hours

Institute shall offer a course for Open Elective from Science/Commerce/Management stream bucket provided by the University of Mumbai.

@ Institute shall offer a course for MDM from other Engineering Boards Group.

PEC-1 Details

Course Code	Course Description
PEC5011	Data Compression and Cryptography
PEC5012	Data Structure and Algorithms
PEC5013	Machine Learning
PEC5014	Cloud Computing & Security
Lab Code	Lab Description
PEL5011	Data Compression and Cryptography Laboratory
PEL5012	Data Structure and Algorithms Laboratory
PEL5013	Machine Learning Laboratory
PEL5014	Cloud Computing & Security Laboratory

Course Code	Course Description	Examination scheme							
		Internal Assessment Test (IAT)			End Sem. Exam Marks	End Sem. Exam Duration (Hrs)	Term Work (Tw)	Oral & Pract.	Total
		IAT-I	IAT-II	Total (IAT-I) + IAT-II)					
PCC501	Computer Communication Networks	20	20	40	60	2	--	--	100
PCC502	Electromagnetics and Antenna	20	20	40	60	2	--	--	100
PCC503	Discrete Time Signal Processing	20	20	40	60	2	--	--	100
PEC501	PEC-1	20	20	40	60	2	--	--	100
MDC501	Multidisciplinary Minor	20	20	40	60	2	--	--	100
PCL501	Communication Networks Laboratory	--	--	--	--	--	25	--	25
PCL502	Electromagnetics and Antenna Laboratory	--	--	--	--	--	25	25	50
PCL503	Discrete Time Signal Processing Laboratory	--	--	--	--	--	25	25	50
PEL501	PEL-1	--	--	--	--	--	25	25	50
MDL501	Multidisciplinary Minor Laboratory	--	--	--	--	--	25	25	50
OECL501	To be taken from the bucket provided by the University from other Faculty	--	--	--	--	--	50	--	50
IKS501	IKS as per Groups	--	--	--	--	--	50	--	50
Total		100	100	200	300	10	225	100	825

Program Structure for Third Year of Electronics & Telecommunication
UNIVERSITY OF MUMBAI (With Effect from 2026-2027)

SEMESTER VI

Course Code	Course Description	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Practical	Tutorial	Theory	Tutorial	Practical	Total Credits
PCC601	Image Processing and Machine Vision	3	--	--	3	--	--	3
PCC602	Digital VLSI	3	--	--	3	--	--	3
PEC601	PEC-2	3	--	--	3	--	--	3
PEC602	PEC-3	3	--	--	3	--	--	3
MDC601	Multidisciplinary Minor	3	--	--	3	--	--	3
VSEC601	Mini-Project – II	--	4	--	--	--	2	2
AEC601	Professional Skills	--	2*+2	--	--	--	2	2
PCL601	Image Processing and Machine Vision Laboratory	--	2	--	--	--	1	1
PCL602	Digital VLSI Laboratory	--	2	--	--	--	1	1
PEL601	PEL-2	--	2	--	--	--	1	1
PEL602	PEL-3	--	2	--	--	--	1	1
MDL601	Multidisciplinary Minor Laboratory	--	2@	--	--	--	1	1
Total		15	18	00	15	00	09	24

* Two hours of practical class to be conducted for full class as demo/discussion.

Theory / Tutorial 1 credit for 1 hour and Practical 1 credit for 2 hours

@ Institute shall offer a course for MDM from other Engineering Boards.

PEC-2 and PEC-3 Details

Course Code	Course Description
PEC6011	Database Management System
PEC6012	Analysis of Algorithms
PEC6013	Deep Learning
PEC6014	Internet of Things
PEC6021	Embedded System
PEC6022	Robotics
PEC6023	Web Design
PEC6024	Network Management in Telecommunication
Lab Code	Lab Description
PEL6011	Database Management System Laboratory
PEL6012	Analysis of Algorithms Laboratory
PEL6013	Deep Learning Laboratory
PEL6014	Internet of Things Laboratory
PEL6021	Embedded System Laboratory
PEL6022	Robotics Laboratory
PEL6023	Web Design Laboratory
PEL6024	Network Management in Telecommunication Laboratory

Course Code	Course Description	Examination scheme							
		Internal Assessment Test (IAT)			End Sem. Exam Marks	End Sem. Exam Duration (Hrs)	Term Work (Tw)	Oral & Pract.	Total
		IAT-I	IAT-II	Total (IAT-I) + IAT-II)					
PCC601	Image Processing and Computer Vision	20	20	40	60	2	--	--	100
PCC602	Digital VLSI	20	20	40	60	2	--	--	100
PEC601	PEC-1	20	20	40	60	2	--	--	100
PEC602	PEC-2	20	20	40	60	2	--	--	100
MDC601	Multidisciplinary Minor	20	20	40	60	2	--	--	100
VSEC601	Mini-Project – II	--	--	--	--	--	50	--	50
AEC601	Professional Skills	--	--	--	--	--	25	--	25
PCL601	Image Processing and Computer Vision Laboratory	--	--	--	--	--	25	25	50
PCL602	Digital VLSI Laboratory	--	--	--	--	--	25	25	50
PEL601	PEL-1	--	--	--	--	--	25	25	50
PEL602	PEL-2	--	--	--	--	--	25	25	50
MDL601	Multidisciplinary Minor Laboratory	--	--	--	--	--	25	25	50
Total		100	100	200	300	10	200	125	825

Vertical – 1 Major

TE EXTC Vert-1 Syllabus 06-05-2026 Light WM

Detail Syllabus

TE EXTC Vert-1 Syllabus-06-05-2026 Light WM

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
PCC501	Computer Communication Networks	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
PCC501	Computer Communication Networks	20	20	40	60	2	--	--	100

Rationale:

The Computer & Communication Networks (CCN) subject forms a core foundation for students in Electronics & Telecommunication Engineering. In today's digital era, almost every application, ranging from mobile communication and cloud computing to IoT, AI systems, and e-governance, relies on efficient and secure networking.

Prerequisite: -

Course Objectives:

1. To provide an understanding of OSI and TCP/IP architectures, layered protocols, switching techniques, networking standards, and layer-wise network devices.
2. To understand network addressing mechanisms and physical layer technologies for reliable data transmission over wired and wireless media.
3. To study data link layer services, error and flow control mechanisms, HDLC protocol operation, and medium access control techniques for efficient data transmission
4. To understand network layer services, IP addressing and routing mechanisms, congestion control techniques, and QoS provisioning in packet-switched networks.
5. To study transport layer services, TCP and UDP operation, checksum computation, and flow and congestion control mechanisms.
6. To introduce application layer protocols and fundamental network security mechanisms for securing IP and wireless networks.

Course Outcomes:

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

1. Understand network architectures and protocols, and differentiate layer-wise networking devices in the context of modern networks.
2. Differentiate addressing schemes and analyze physical layer transmission media, broadband standards (DSL, HFC), and wireless physical layer techniques
3. Analyze data link services, evaluate ARQ efficiency, explain HDLC frame operations, and compare MAC protocols such as ALOHA and CSMA/CD
4. Analyze IP addressing schemes, routing algorithms and protocols, subnetting techniques, IPv4/IPv6 operations, and evaluate congestion control and QoS mechanisms.

5. Explain TCP/UDP functionality, perform checksum calculations, and analyze error, flow, and congestion control techniques in the transport layer.
6. Explain application layer protocols and analyze network security methods, firewalls, and packet filtering techniques.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic computer and network familiarity recommended	-	-
I	Introduction to N/W architecture	1.1 Overview of OSI and TCP/IP model, switching techniques. Overview of Modern networking trends - cloud networking and IOT. 1.2 Protocols and standards, the need for a layered protocol architecture. 1.3 Layer-wise network hardware devices (NIC, Repeaters, Hubs, Bridges, Switches, Routers, Gateway, and their comparison) Self-learning Topic: Evolution of network devices in next-generation networks.	4	CO1
II	Physical Layer	2.1 Addressing: physical / logical /port addressing and socket addressing. 2.2 Physical layer- transmitting media, broadband standard -DSL, HFC and wireless physical layer. Self-learning Topic: Role of physical layer technologies in enabling end-to-end network connectivity.	3	CO2
III	Data Link Layer	3.1 Data link services: Framing, Flow control, Error control 3.2 ARQ methods: transmission efficiency, Piggybacking 3.3 High-Level Data Link Control (HDLC): HDLC configurations, Frame formats, HDLC bit stuffing and de-stuffing, Typical frame exchanges. 3.4 Medium Access Control Protocols: ALOHA,	8	CO3

		Slotted ALOHA, CSMA, CSMA/CD Self-learning Topic: Ethernet frame structure and collision handling in modern LANs.		
IV	Network layer	4.1 Network layer services and functions. 4.2 Internet Protocol: Principles of Internetworking, requirements, IPv4 packet, IPv4 addressing (classful and classless (CIDR)) 4.3 Routing in Packet Switching Networks: Characteristics, Routing Strategies 4.4 Routing algorithms: Link state Routing, Distance vector Routing and Path vector, routing, Routing protocols: RIP, OSPF, BGP and EIGRP. 4.5 Subnetting, super netting, VLSM, and NAT 4.6 Introduction to ICMP, ARP, RARP 4.7 IPv6 (IPv6 Datagram format, comparison with IPv4, and transition from IPv4 to IPV6 4.8 Quality of service 4.9 Congestion control algorithms: Open-loop congestion control, Closed-loop congestion control, QoS parameters, Token& Leaky bucket algorithms Self-learning Topic: Software Defined Networking (SDN) and its impact on network layer routing.	12	CO4
V	Transport layer	5.1 Connectionless and Connection-oriented services at the transport layer, Transmission Control Protocol (TCP): TCP Services, TCP Segment, TCP three-way handshake 5.2 User Datagram Protocol (UDP), UDP Services, UDP Datagram 5.3 TCP and UDP checksum calculation 5.4 Error control, TCP Flow control (sliding	6	CO5

		Window), TCP Congestion Control: Slow Start Self-learning Topic: Comparison of reliable and unreliable transport services in real-time and multimedia applications.		
VI	Application Layer	6.1 Introduction to Application Layer Protocols: HTTP, FTP, DNS, SMTP, TELNET, SSH, DHCP 6.2 Network security 6.3 Overview of Network Security (Security Methods, Symmetric-Key Cryptography, Public-Key Cryptography) 6.4 Security of IP and Wireless Networks 6.5 Firewalls and Packet Filtering. Self-learning Topic: Secure communication in client-server and web-based applications.	6	CO6

Textbooks:

1. Data Communications and Networking – Behrouz A. Forouzan, Sixth Edition TMH.
2. Computer Networks -- Andrew S Tanenbaum, 6th Edition, Pearson Education, 2013.

Reference Books:

1. Alberto Leon Garcia, “Communication Networks”, McGraw-Hill Education, Second Edition.
2. Data and Computer Communications, William Stallings, 11th Edition, Pearson Education.

Online References:

Sr. No.	Website Name
1.	SWAYAM Course Page: https://onlinecourses.swayam2.ac.in/ntr25_ed138/preview – Computer Networks by Dr. Karthik N, NIT Puducherry (current/ongoing course)
2.	Communication Networks (NPTEL via SWAYAM) A classic networking course often offered via SWAYAM/NPTEL portal: https://onlinecourses.nptel.ac.in/noc24_ee71/preview – Communication Networks (IIT Kharagpur)
3.	CISCO-Networking Basics: https://www.netacad.com/courses/networking-basics?courseLang=en-US

Assessment:**Internal Assessment (IA) Test:**

Assessment consists of two class tests of 20 marks each. The first class test (Internal Assessment I) is to be conducted when approximately 40% syllabus is completed, and the second class test (Internal Assessment II) when an additional 35% syllabus is completed. The duration of each test shall be one hour.

End-of-Semester Examination:

1. The question paper will comprise a total of 06 questions, each carrying 15 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and should cover maximum content of the entire syllabus.
4. Remaining questions will be randomly selected from all the modules as per the weightage of each module (which is proportional to number of respective lecture hours mentioned in the syllabus).

TE EXTC Vert-1 Syllabus-06-05-2026 Light WM

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
PCC502	Electromagnetics and Antenna	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract. / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
PCC502	Electromagnetic and Antenna	20	20	40	60	2	—	--	100

Rationale:

Electromagnetic Theory studies electric and magnetic fields and electromagnetic wave propagation based on Maxwell's equations. It provides the fundamental basis for wireless communication systems.

Prerequisite:

1. BSC201 Applied Mathematics-II
2. 2304113 Analog and Digital Communication

Course Objectives:

1. Understand electromagnetic fields, Maxwell's equations, and EM wave propagation in different media.
2. Study radiation mechanisms and evaluate basic antenna parameters.
3. Analyze and design antenna arrays and different antenna types.
4. Introduce advanced antennas and their applications in modern wireless systems

Course Outcomes:

On successful completion, the students will be able to:

1. Explain electromagnetic fields (static and time-varying) using Maxwell's equations.
2. Apply Maxwell's equations to analyze electromagnetic wave propagation in different media and compute power in EM waves.
3. Derive and analyze field equations for basic radiating elements and evaluate antenna parameters such as radiation pattern, beam width, directivity, gain, antenna efficiency and types of polarization.
4. Design and analyze different types of array antenna structures and determine their radiation characteristics.
5. Design and evaluate different antenna types such as Yagi, Helical, Log-periodic, Horn, Micro

strip, and Reflector antennas based on performance parameters.

6. Explain and analyse the principles and applications of advanced antennas such as MIMO, UWB, metamaterial, and antennas used in 4G/5G and IoT systems.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Fundamental Knowledge	Vector Algebra, Vector calculus, coordinate system	1	-
I		Introduction to Static Fields	6	CO1
	1.1	Charge, Coulomb's law, Charge configurations, Electric field intensity, Electric flux density, Gauss's law and applications, Current density, and Continuity equation		
	1.2	Scalar Electric Potential, Potential gradient, Laplace's and Poisson's equations		
	1.3	Biot-Savart Law, Ampere Circuit law, Gauss's law for magnetic field, Vector magnetic potential		
	Self-learning Topics	Coulomb's law and Gauss's law applications		
II		Electromagnetic Field and Maxwell's Equations	6	CO2
	2.1	Faraday's Law, Displacement current density, Maxwell's equation for time varying field, Boundary conditions.		
	2.2	EM wave propagation through lossy, perfect dielectric and conducting medium, Skin Depth		
	2.3	Power in EM Wave: Poynting theorem and Poynting vector		
	Self-learning Topics	Stokes' Theorem applications in Maxwell's equations		
III		Basic of Antennas	8	CO3
	3.1	Basic concepts: Radiation mechanism, Near field and far field radiation, retarded potential		
	3.2	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, Friis's transmission formula		

	3.3	Wire Elements: Infinitesimal dipole, Wire dipole, Monopole antennas: radiation field derivations and related parameters.		
	Self-learning Topics	Propagation used in Practical Communication Systems: Ground, Sky and Space Wave Propagation		
IV		Antenna Arrays	5	CO4
	4.1	Linear arrays of two isotropic point sources, linear arrays of N elements, Principle of pattern multiplication		
	4.2	Introduction to Planar and circular arrays		
	Self-learning Topics	Beam steering concept, phased array basics		
V		Types of Antennas	8	CO5
	5.1	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		
	5.2	Reflector Antennas: Plane Reflectors, Corner Reflectors and Parabolic Reflector		
	5.3	Patch Antenna: Micro strip antenna, Feeding Techniques, Introduction to design of Micro strip antenna (Rectangular and circular patch)		
	Self-learning Topics	Fractal antennas, Reconfigurable antennas Dielectric resonator antenna		
VI		Advanced Antenna for practical applications	5	CO6
	6.1	Advanced antenna: MIMO, UWB, antenna used for 4G/5G application, meta-material antennas & antennas used for IoT devices		
	Self-learning Topics	Study of electromagnetic radiation hazards, biological effects of RF radiation, SAR, international safety standards, and radiation safety considerations in antenna systems		

Textbooks:

1. Electromagnetic Waves and Radiating Systems- Jordan and Balmain, PHI, 2nd edition
Principles of Electromagnetics Engineering- Matthew N. O. Sadiku, S.V. Kulkarni, Oxford University press, 6th edition
2. Antenna Theory: Analysis and Design, Costantine A. Balanis, John Wiley Publication, 4th Edition
3. Antenna and wave Propagation, John D Kraus, A S Khan, McGraw Hill, 4th edition
4. Antenna Theory and Design. Stutzman, Theile, John Wiley and Sons, 3rd edition

Reference Books:

1. Engineering Electromagnetics, William H Hayt and John A Buck, Tata McGraw-Hill Publishing Company Limited, 7th edition
2. Antennas and Radio Wave Propagation, R. E. Collin, McGraw Hill, International Student Edition
3. Electromagnetics with Applications, K. D. Prasad, New Age International (P) Limited, Publishers, 2nd edition.

Online References:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/108101092
2.	https://nptel.ac.in/courses/108105114

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
PCC503	Discrete-Time Signal Processing	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
PCC503	Discrete-Time Signal Processing	20	20	40	60	2	--	--	100

Prerequisite:

2303111 -Mathematics for Signal Analysis

Course Objectives:

1. To develop a thorough understanding of the discrete Fourier transform and its use in spectral analysis and frequency domain filter designing.
2. To design and realize IIR filters and FIR filters, gain an appreciation for the tradeoffs necessary in the filter design and to evaluate the effects of finite word lengths on the filters.
3. To introduce applications of digital signal processing in the field of biomedical and audio signal processing.

Course Outcomes:

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

1. **Analyze** discrete-time signals using DFT and FFT techniques for frequency-domain representation and linear filtering applications.
2. **Analyze** IIR digital filters using analog filter approximations and s-plane to z-plane transformation techniques to meet given frequency specifications.
3. **Analyze** FIR digital filter characteristics obtained using windowing and frequency sampling techniques and compare them with IIR filters.
4. Interpret the different realization structures of Digital IIR and FIR filters.
5. Analyze the impact of hardware limitations on the performance of digital filters.
6. Apply signal processing concepts and algorithms in applications related to the field of biomedical and audio signal processing.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	-	-	-
I	Discrete Fourier Transform & Fast Fourier Transform	1.1 Discrete Fourier transform (DFT): Definition and mathematical representation, DFT as a linear transformation, Properties of the DFT- Convolutional property, Relationship between Linear & Circular Convolution, Filtering of long data sequences: Overlap-Save and Overlap-Add Method 1.2 Fast Fourier Transform: Radix-2 Fast Fourier Transforms (FFT), Radix-2 decimation in time and decimation in frequency FFT algorithms, Inverse FFT Self-Learning: Relationship of the DFT to DTFT & z-Transform, Goertzel Algorithm, Chirp-Z Algorithm, Application of FFT in spectrum Analysis, Speech & Biomedical signals	05 03	CO1
II	IIR Digital filters	2.1 LTI systems as frequency-selective filters like low pass, high pass, band pass, notch, comb, all-pass filters (concept only), and digital resonators, Analog filter approximations: Butterworth, Chebyshev I 2.2 Mapping from the s-plane to the z-plane - impulse invariant and bilinear transformation, Design of IIR digital filters (Butterworth and Chebyshev-I) from analog filters using impulse invariant and bilinear transformation techniques Self-Learning: Elliptic Filter approximation, Analog and digital frequency transformations	03 05	CO2
III	FIR Digital Filters	3.1 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	04	CO3

		3.2 Design of FIR filters using Window techniques (Rectangular, Hamming, Hanning), Design of FIR filters using Frequency Sampling Technique –Type I low-pass filter design, Comparison of IIR and FIR filters Self-Learning: Design of FIR filters using Window techniques (Blackman, Bartlett, Kaiser/Bessel)	05	
IV	Digital Filter Structures	4.1 Realization structures for FIR systems: Cascade form, Frequency sampling structure, Lattice structure 4.2 Realization structures for IIR systems: Cascade form and parallel form structures, Lattice Ladder structure Self-Learning: Comparison of FIR and IIR realization structures in terms of computational efficiency and numerical stability	02 03	CO4
V	Finite Word Length Effects in Digital Filters	5.1 Rounding and truncation errors, Quantization error, Output noise power from a digital system 5.2 Product quantization, Noise model for direct form and cascaded IIR structure (first order), Coefficient quantization error and zero input limit cycle in digital filters Self-Learning: Overflow, saturation, and scaling in fixed-point digital filter implementation.	02 03	CO5
VI	Applications of Digital Signal Processing	6.1 Application of DSP for ECG and EEG signals analysis. 6.2 Application of DSP for echo cancellation and sub-band coding of the speech signal Self-Learning: Application to Radar, Application to image processing/ Wavelets	02 02	CO6

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 McGraw-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.
4. S Salivahan, C Gnanapriya, "Digital Signal Processing", Mc Graw Hill Education (India) limited, 4th Edition, 2015.
5. Monson H Hayes, "Digital Signal Processing", Schaum's Outline Series, 2nd Edition, 2011.
6. Rangaraj M. Rangayyan, "Biomedical Signal Analysis- A Case Study Approach", Wiley 2002.

Online References:

Sr. No.	Website Name
1.	Course: Digital Signal Processing By Prof. S.C. Dutta Roy, IIT Delhi https://nptel.ac.in/courses/117102060
2.	Course: Digital Signal Processing By Prof. V. M. Gadre, IIT Bombay https://nptel.ac.in/courses/108101174
3.	Course: Digital Signal Processing By Prof. T. K. Basu, IIT Kharagpur https://nptel.ac.in/courses/108/105/108105055

Module	Self-Learning Topic	Speaker / Host Institute	NPTEL Video Link
I	Relationship of the DFT to DTFT & Z Transform	Prof. S.C. Dutta Roy (IIT Delhi)	https://nptel.ac.in/courses/117102060
I	Goertzel Algorithm & Chirp-Z Algorithm	Prof. T.K. Bhattacharya (IIT Kharagpur)	https://www.youtube.com/watch?v=EZLKTEKCfO8

I	Application of FFT in Spectrum Analysis, Speech & Biomedical signals	Prof. Sudipta Mukhopadhyay (IIT Kharagpur)	https://nptel.ac.in/courses/108105101
II	Elliptic Filter approximation	Prof. S.C. Dutta Roy (IIT Delhi)	https://nptel.ac.in/courses/117102060
II	Analog and digital frequency transformations	Prof. T.K. Bhattacharya (IIT Kharagpur)	https://nptel.ac.in/courses/108105055
III	Design of FIR filters using Window techniques (Blackman, Bartlett, Kaiser/Bessel)	Prof. V.M. Gadre (IIT Bombay)	https://nptel.ac.in/courses/117101001
IV	Comparison of FIR and IIR realization structures (Efficiency & Stability)	Prof. S.D. Agashe (IIT Bombay)	https://nptel.ac.in/courses/108102041
V	Overflow, saturation, and scaling in fixed-point implementation	Prof. Amit Patra (IIT Kharagpur)	https://nptel.ac.in/courses/108105157
VI	Application of DSP in Radar Signal Processing	Prof. A. Das (IIT Kharagpur)	https://nptel.ac.in/courses/108105154
VI	Application to Image processing and Wavelets	Prof. V.M. Gadre (IIT Bombay)	https://nptel.ac.in/courses/117101001

Assessment:

Internal Assessment (IA) Test:

Assessment consists of two class tests of 20 marks each. The first class test (Internal Assessment I) is to be conducted when approximately 40% syllabus is completed, and the second class test (Internal Assessment II) when an additional 40% syllabus is completed. The duration of each test shall be one hour. The addition of the two tests will be considered as IA marks.

End-of-Semester Examination:

Weightage to each of the modules in the end-semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum

1. The question paper will comprise a total of **06 questions**, each carrying **15 marks**.
2. A total of **04 questions** need to be solved.
3. **Question No. 01** will be **compulsory** and based on the entire syllabus, wherein 3 or 5 sub-questions will be asked
4. Remaining questions will be randomly selected from all the modules as per the weightage of each module.

TE EXTC Vert-1 Syllabus-06-05-2026 Light VM

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tuts	Theory	Practical	Tuts	Total
PEC5011	Data Compression and Cryptography	3	---	---	3	--	--	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
PEC5011	Data Compression and Cryptography	20	20	40	60	2	--	--	100

Pre requisite:

1. 2303111-Mathematics for Signal Analysis
2. 2304113-Analog and Digital Communication

Course Objectives: The course aims to

1. Introduce the fundamental concepts, types, and applications of Text Compression, Image compression and Video compression
2. Familiarize students about Symmetric and Asymmetric key Encryption techniques.
3. Develop understanding of network security issues and solutions.

Course Outcomes: After successful completion of the course, students will be able

1. To gain a fundamental understanding of data compression methods for text and related issues in the storage, access, and use of large data sets
2. To compress audio signals using suitable techniques.
3. To select, giving reasons that are sensitive to the specific application and particular circumstance, most appropriate compression techniques for image and video information
4. To analyse how the basic design criteria for various cryptosystems like confusion, diffusion and number theory are used in cryptographic techniques.
5. To Illustrate the applications of Cryptography in Encryption and Authentication
6. To identify the various techniques for network security

Module No.	Topics	Hours	CO Mapping
1	Introduction to Compression 1.1 Compression Techniques: Loss less compression, Lossy Compression, Measures of performance 1.2 The Huffman coding algorithm: Minimum variance Huffman codes - Encoding and Decoding, Adaptive Huffman coding: Update procedure, Encoding procedure, Decoding procedure. 1.3 Arithmetic encoding and decoding 1.4 Dictionary-based coding- Static Dictionary: Diagram Coding, Adaptive Dictionary. The LZ77 Approach, The LZ78 Approach, The LZW Approach Self-study Topics: Compressed File Formats, Modelling and coding,	8	CO1
2	Audio Coding & Psychoacoustic Modeling 2.1 Digital audio basics 2.2 Frequency masking and temporal masking 2.3 Lossy Audio compression, μ -law and A-law companding 2.4 MP3 audio standard 2.5 Advanced Audio Coding Self-study Topics: Opus Codec, Dolby AC3	4	CO2
3	Image and Video Compression 3.1 Image Compression Principles 3.2 DCT, JPEG standard and JPEG 2000 3.3 Fundamentals of Video and Intra-frame coding 3.4 Motion estimation and compensation 3.5 Introduction to MPEG-4 3.6 Introduction to H.265 encoder & decoder Self-study Topics: JBIG Standard, JPEG LS, MPEG-7, DWT	6	CO3
4	Cryptography & Information Security 4.1 Active attacks and Passive Attacks 4.2 Security Goals 4.3 Monoalphabetic and polyalphabetic ciphers 4.4 Substitution & transposition ciphers-Hill Cipher, Playfair Cipher and Rail fence Cipher 4.5 Stream vs block cipher 4.6 PKI Infrastructure Self-study Topics: Discrete Logarithm, Steganography.	6	CO4
5	Symmetric Encryption and Asymmetric Encryption 6.1 Symmetric vs asymmetric cipher 6.2 Data Encryption Standard, Double DES, Meet in Middle Attack 6.3 Advanced Encryption Standard 6.4 Number Theory - Fermat's little theorem, Euler Totient Function, Extended Euclid Algorithm and Primitive roots	10	CO5

	6.5 RSA Encryption 6.6 ECC Cryptography 6.7 Diffie- Hellman Key Exchange Algorithm 6.8 Hash and MAC Authentication, Expand Hashing, SHA2, SHA3, Self-Study Topics: Data Integrity threats, Digital Signatures, Blowfish algorithm.		
6	Network security Intrusion Detection Systems and Intrusion prevention systems, Digital Immune Systems, Digital certificates Biometric Authentication, Secure Electronic Transaction, Ethical hacking, Block chain basics for security. Self-Study Topics: Kerberos, SSL and TLS.	5	CO6

No Question to be asked from self-study topics in Internal assessment and End semester Examination.

Text Books:

1. Khalid Sayood , “Introduction to Data Compression”, Elsevier, 5th Edition, 2017.
2. David Saloman, “Data Compression: The Complete Reference”,4th Edition, Springer, 2007.
3. William Stallings, “Cryptography and Network Security Principles and Practices”, Pearson Education, 5th Edition, 2020.

References:

1. Behrouz A. Forouzan, “Cryptography and Network Security”, Tata McGraw-Hill, 3rd Edition, 2015
2. Mark Nelson, Jean- Loup Gailly, “The Data Compression Book”, 2nd Edition, BPB Publications,2014.
3. Atul Kahate, “Cryptography and Network Security”, McGraw-Hill ,4th Edition, 2019.

NPTEL Courses:

1. An Introduction to Information Theory, IIT Kanpur by Prof. Adrish Banerjee
2. Network security , IIT Bombay by Prof. Gaurav S. Kasbekar
3. Cryptography and Network Security, IIT Kharagpur by Prof. Sourav Mukhopadhyay

Assessment:

Internal Assessment (IA) for 20 marks each:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of the syllabus content must be covered in the IAT-I and the remaining 40% to 50% of the syllabus content must be covered in the IAT-II.

End Semester Theory Examination:

➤ Question paper format

- Question Paper will comprise a total of six questions each carrying 15 marks

- Q.1 will be compulsory and should cover the maximum contents of the syllabus
- Remaining questions will be mixed in nature (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of four questions need to be answered.

TE EXTC Vert-1 Syllabus-06-05-2026 Light WM

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
PEC5012	Data Structure & Algorithms	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
PEC5012	Data Structure & Algorithms	20	20	40	60	2	-	-	100

Rationale:

Data Structures & Algorithms (DSA) is a core subject in computer engineering that equips students with the theoretical and practical foundations necessary for efficient problem-solving. The study of DSA enables learners to understand how information can be organized, accessed, and manipulated to achieve optimal performance in computational tasks. It bridges mathematical theory with practical applications, fostering analytical thinking and algorithmic design skills.

Prerequisite: -

Course Objectives:

1. Learn linear and nonlinear data structures, as well as how they are implemented.
2. Analyze the data structures, such as stacks and queues
3. Learn the terminologies, types and various operations in a linked list
4. Explore the fundamentals of Trees & Graphs and learn about their operations and applications
5. Provide mathematical approaches for the Analysis of Algorithms
6. Understand and solve problems using various algorithmic approaches

Course Outcomes:

At the end of completing the course of Data Structure & Algorithms, a student will be able to:

1. Classify and apply the concepts of Linear and Non-Linear data structures in real-life problem-solving, and apply the operations like insertion, deletion, and traversal operations on them.
2. Explore data structures such as Stacks and Queues, learn about their operations, and use them to solve problems in a variety of real-world domains.
3. Apply the concept of a linked list to evaluate the problems in diverse applications.
4. Analyze and apply the concepts of Trees and Graphs & their applications in real-life problem-solving
5. Analyze the complexity of the divide and conquer & greedy strategy.
6. Explain and apply string matching techniques.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Concepts of Functions, Recursion, Arrays, Pointers, Structures and C programming constructs.	-	-
I	Introduction to Data Structures	Introduction to Data Structures, Concept of ADT, Types of Data Structures- Linear and Nonlinear, Operations on Data Structures. Self-learning Topics: Introduction to Data Structures – Introduction To Data Structures Data Structures Cplusplus Tutorial (swiftorial.com)	2	CO1
II	Stack and Queues	Introduction, ADT of Stack, Operations on Stack, Array Implementation of Stack, Applications of Stack-Well form-ness of Parenthesis, Infix to Postfix Conversion and Postfix Evaluation Introduction, ADT of Queue, Operations on Queue, Array Implementation of Queue, Types of Queue-Circular Queue, Priority Queue, and Double Ended Queue, Applications of Queue. Self-learning Topics: Programiz https://www.programiz.com/dsa/stack https://www.programiz.com/dsa/queue	7	CO2
III	Linked List	Introduction, Representation of Linked List, Linked List v/s Array, Types of Linked List - Singly Linked List, Circular Linked List, Doubly Linked List, Operations on Singly Linked List and Doubly Linked List, Stack & Queue using Singly Linked List, Singly Linked List Application-Polynomial Representation & Addition. Self-learning Topics: TutorialsPoint https://www.tutorialspoint.com/data_structures_algorithms/linked_list_algorithms.htm	9	CO3

IV	Trees & Graphs	Introduction, Tree Terminologies, Binary Tree, Binary Tree Representation, Types of Binary Tree, Binary Tree Traversals, Binary Search Tree, Operations on Binary Search Tree, Applications of Binary Tree-Expression Tree, Huffman Encoding, Search Trees-AVL, rotations in AVL Tree, operations on AVL Tree Introduction, Graph Terminologies, Representation of Graph, Graph Traversals-Depth First Search (DFS) and Breadth First Search (BFS), Graph Application- Topological Sorting. Self-learning Topics: GeeksforGeeks Binary Tree Data Structure - GeeksforGeeks Graph Algorithms - GeeksforGeeks	9	CO4
V	Divide and Conquer Approach & Greedy Method	General method, Merge sort, Quick sort, Finding minimum & maximum algorithms and their Analysis, Analysis of Binary search. General Method, Single source shortest path: Dijkstra Algorithm Fractional Knapsack problem, Job sequencing with deadlines, Minimum cost spanning trees: Kruskal and Prim's algorithms Self-learning Topics: GeeksforGeeks Introduction to Divide and Conquer Algorithm - GeeksforGeeks Greedy Algorithms Tutorial - GeeksforGeeks	8	CO5
VI	String Matching Algorithms	The Naïve string-matching algorithm, The Rabin Karp algorithm, The Knuth-Morris-Pratt algorithm Self-learning Topics: KMP Algorithm - GeeksforGeeks Rabin-Karp Algorithm for Pattern Searching - GeeksforGeeks	4	CO6

Textbooks:

1. Aaron M Tenenbaum, Yedidyah Langsam, Moshe J Augenstein, "Data Structures Using C", Pearson Publication
2. Data Structures Using C, ISRD Group, 2ndEdition, Tata McGraw-Hill.
3. T. H. Cormen, C.E. Leiserson, R. L. Rivest, and C. Stein, "Introduction to algorithms", 2nd Edition, PHI Publication 2005
4. Ellis Horowitz, Sartaj Sahni, S. Rajsekar. "Fundamentals of computer algorithms" University Press.

Reference Books:

1. E. Balagurusamy, "Data Structure Using C", Tata McGraw-Hill Education India
2. GAV PAI, "Data Structures", Schaum's Outlines.
3. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGraw-Hill Edition.
4. S. K. Basu, "Design Methods and Analysis of Algorithm", PHI

Online References:

Sr. No.	Website Name
1.	Data Structures and Algorithms Specialization https://www.coursera.org/specializations/data-structures-algorithms
2.	Data Structures Fundamentals https://www.edx.org/course/data-structures-fundamentals
3.	Swayam: Design and analysis of algorithms https://swayam.gov.in/nd1_noc19_cs47/preview
4.	MOOC List https://www.mooc-list.com/tags/algorithms

Assessment:**Internal Assessment (IA) Test:**

Assessment consists of two class tests of 20 marks each. The first-class test (Internal Assessment I) is to be conducted when approximately 40% syllabus is completed, and the second-class test (Internal Assessment II) when an additional 35% syllabus is completed. The duration of each test shall be one hour.

End-of-Semester Examination:

1. The question paper will comprise a total of 06 questions, each carrying 15 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and should cover maximum content of the entire syllabus.
4. Remaining questions will be randomly selected from all the modules as per the weightage of each module (which is proportional to number of respective lecture hours mentioned in the syllabus).

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tuts.	Theory	Practical	Tuts.	Total
PEC5013	Machine Learning	3	---	---	3	--	--	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
PEC5013	Machine Learning	20	20	40	60	2	—	--	100

Pre-requisite:

1. BSC101-Applied Mathematics -I
2. BSC201-Applied Mathematics -II
3. 2304111-Neural Networks and Fuzzy Logic

Course Objectives: The course aims to

1. Introduce the fundamental concepts, types, and applications of Machine Learning
2. Explain machine learning model, train the model evaluate performance using standard metrics
3. Develop understanding of regression and tree-based learning techniques to model real-world datasets and evaluate their performance using standard metrics.
4. Familiarize students about classification and clustering algorithms for supervised and unsupervised learning problems.
5. Develop practical ML solutions using standard datasets and validation techniques.

Course Outcomes: After successful completion of the course, students will be able to

1. Explain the concept of machine learning, its types, applications, and feature engineering
2. Select the machine learning model , train them and evaluate their performance using performance metrics
3. Apply supervised learning techniques for regression tasks
4. Implement classification tasks using supervised learning techniques
5. Analyse and implement unsupervised learning for data exploration and pattern recognition.
6. Develop ML solutions for real-world applications

DETAILED SYLLABUS:

Module No.	Topics	Hours	CO Mapping
1	Introduction to Machine Learning 1.1 Machine Learning and types of Machine Learning (supervised and unsupervised, reinforcement) 1.2 Issues in Machine Learning 1.3 Basic types of data in machine learning 1.4 Basics of Feature Engineering in Machine Learning-Feature extraction, Feature subset selection and Feature selection approaches Self-learning Topics: Importance of Statistical tools in machine learning, Tools in Machine learning	6	CO1
2	Modelling and Evaluation 2.1 Data Pre-processing-Dimensionality Reduction 2.2 Selecting a Model-Predictive Model and Descriptive Model 2.3 Training a model- K-fold cross validation, Train-Validation-Test Split 2.4 Model Representation and Interpretability- Training Error, Generalization error, Overfitting, Under fitting, Bias-Variance trade-off, Concept of hyper-parameter tuning. 2.5 Performance Metrics: Confusion Matrix, Sensitivity, Specificity, Precision, Recall, F-measure, RMSE Self-learning Topics: Hypothesis Testing, Monte Carlo Approximation	7	CO2
3	Supervised Learning for Regression 3.1 Learning with Regression: Linear Regression, Multivariate Linear Regression, Polynomial Regression model and Logistic Regression, 3.2 Learning with Trees: Decision Trees, Constructing Decision Trees using Gini Index (Regression) Self-learning Topics: Maximum Likelihood Estimation, eXtreme Gradient Boosting	6	CO3
4	Supervised Learning for Classification: 4.1 k-Nearest Neighbour based classification 4.2 Support Vector Machine for linear classification 4.3 Decision Tree in classification 4.4 Random Forest Algorithm 4.5 Bayesian Learning: Introduction to Probability-based Learning, Classification Using Bayes Model Self-learning Topics: Ensemble Learning Bagging and Boosting	8	CO4
5	Unsupervised Learning for clustering 5.1 Supervised Learning Vs unsupervised learning 5.2 k-Means clustering 5.3 Hierarchical Clustering 5.3 Density Based Methods DBSCAN	6	CO5

	Self-learning Topics: Gaussian Mixture Models, Manifold Learning, Neural Network Models for unsupervised learning		
6	Applications of Machine Learning in 6.1 Image Recognition 6.2 Predictive Analysis 6.3 Spam Detection 6.4 Sentiment Analysis 6.5 Market Segmentation 6.6 Q learning Self-learning Topics: Reinforcement learning applications in self driving cars, Industrial Automation, Natural Language Processing and healthcare	6	CO6

*** No question to be asked from self-learning topics in Internal Assessment and End Semester Exam

Text Books:

1. Saikat Dutt, Subramanian Chandramouli and Amit Kumar Das, Machine Learning, Pearson India Education
2. Ethem Alpaydin, Introduction to Machine Learning, 2nd Edition, The MIT Press
3. R. S. Sutton and A. G. Barto, Reinforcement learning: An Introduction (Adaptive Computation and Machine Learning series), 2nd Edition, Bradford Book, 2018.

References:

1. Tom Mitchell, Machine Learning.. First Edition, McGraw- Hill, 1997
2. M. Mohri, A. Rostamizadeh, A. Talwalkar, Foundations of machine learning, MIT Press, 2012.
3. S. N. Sivanandam and S. N. Deepa, Introduction to soft computing, IIIrd Edition, Wiley Publications, India,.
4. S. Haykin, Neural networks and learning machines, IIIrd Edition, Pearson Prentice Hall, India, 2009.

Recommended Swayam NPTEL Courses:

1. Introduction to Machine Learning, IIT Madras Prof. Balaraman Ravindran, nptel.ac.in/courses/106106139

Assessment:

Internal Assessment (IA) for 20 marks each:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of the syllabus content must be covered in the IAT-I and the remaining 40% to 50% of the syllabus content must be covered in the IAT-II.

End Semester Theory Examination:

➤ Question paper format

- Question Paper will comprise a total of six questions each carrying 15 marks
- Q.1 will be compulsory and should cover the maximum contents of the syllabus
- Remaining questions will be mixed in nature (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of four questions need to be answered.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
PEC5014	Cloud Computing and Security	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
PEC5014	Cloud Computing and Security	20	20	40	60	2	-	-	100

Rationale:

Knowledge Area	Rationale for Student	Career Outcome
Virtualization	Understands resource abstraction.	Systems Engineer
Service Models	Learns to optimize working of service models.	Cloud Architect
AAA & Security	Learns to protect multi-tenant data.	Security Analyst
Streaming & CDN	Masters global content delivery.	Full Stack Developer
Edge & Fog	Masters low-latency, distributed systems.	IoT Specialist

Course Pre-requisite: --

Course Objectives:

1. Understand the fundamentals of cloud computing.
2. Appreciate the importance of virtualization in cloud computing.
3. Understand various cloud computing services and platforms.
4. Understand application design concepts in cloud.
5. Understand the security aspects of cloud computing.
6. Understand the advances in cloud computing.

Course Outcomes:

On successful completion of the course learner will be able to:

1. Analyze the fundamental concepts and architecture of cloud computing.
2. Analyze the role of virtualization in cloud computing environments.
3. Evaluate cloud computing services offered by AWS, Azure, and Google Cloud platforms.
4. Design cloud-based applications using appropriate architectural principles.
5. Evaluate security mechanisms and risk management strategies in cloud computing.
6. Analyze emerging advancements such as multimedia cloud, fog computing, edge computing, and real-world cloud applications.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	1. Computer Communication Network 2. Digital Encryption System	-	-
1	Introduction to Cloud Computing	Understand the origin of cloud computing, cloud cube model, NIST model, characteristics of cloud, different deployment models, service models, advantages and disadvantages. Client Server, Distributed, Grid, Cloud Deployment model (Cloud types- Public, Private, Community, Hybrid).Service Models-(IaaS, PaaS, SaaS,).	4	CO1
	Self-Learning Topic	Comparing of Cloud Computing with Peer to Peer architecture		
2	Basics of Virtualization	Introduction & benefit of Virtualization, Implementation Levels of Virtualization, VMM Design Requirements and Providers, Virtualization at OS level, Middleware support for Virtualization, Virtualization structure/tools and mechanisms: Hypervisor and Xen Architecture, Binary Translation with full Virtualization, Para Virtualization with Compiler Support, Virtualization of CPU, Memory and I/O Devices.	7	CO2
	Self-Learning Topic	Hardware support for Virtualization in intel x86 processor – CPU Virtualization – Memory Virtualization and I/O Virtualization – Virtualization in Multicore processors		
3	Cloud Computing Services	Compute Services (EC2, GCE, Azure VM): Provide scalable, on-demand virtual machine instances for running applications. Computing & Storage: Compute: Renting virtual servers(EC2,Google Compute Engine, Azure VMs. Storage: Storing Files and data online (Amazon S3,Google Cloud Storage, Azure Storage) Database Services - Amazon Relational Data Store, Amazon Dynamo DB, Google Cloud SQL, Google Cloud Datastore, Windows Azure SQL Database, Windows Azure Table Service.	10	CO3

	Speed and Data Delivery	Content Delivery (CDN): Using tools like Amazon Cloud front or Azure CDN to make website load faster for users around the world. Big Data & Analytics: Smart Data Analysis: Processing huge amounts of information quickly. Key Tools: Amazon Elastic Map Reduce, Google Big Query and Azure HD Insight.		
	Self-Learning Topic	Application Services - Application Runtimes & Frameworks, Queuing Services, Email Services, Notification Services, Media Services, Open Source Private Cloud Software – Cloud Stack, Eucalyptus, Open Stack		
4	Cloud Application Design	Design Considerations for Cloud Applications - Scalability, Reliability & Availability, Security, Maintenance & Up-gradation, Performance.	6	CO4
	Cloud Application Design Methodologies	Service Oriented Architecture, Cloud Component Model, IaaS, PaaS and SaaS services for cloud applications, Model View Controller, RESTful Web Services.		
	Self-Learning Topic	Data Storage Approaches - Relational (SQL) Approach, Non-Relational (No-SQL) Approach		
5	Cloud & Data Security	Cloud Security: Security for Virtualization Platform, Host security for SaaS, PaaS and IaaS. Data Security: Data Security Concerns, Data Confidentiality and Encryption, Data Availability, Data Integrity, Cloud Storage Gateways, Cloud Firewall.	6	CO5
	AAA Administration for Clouds:	AAA model, SSO for Clouds, Authentication management and Authorization management in clouds, Accounting for Clouds Resource utilization.		
	Self-Learning Topic	Cloud Security Fundamentals		
6	Cloud Computing Applications	Cloud Computing for Health care, Education, Transportation, Manufacturing Industry, Energy System, Mobile Computing.	6	CO6
	Multimedia Cloud	Introduction, Streaming Protocols - RTMP Streaming, HTTP Live Streaming, HTTP Dynamic Streaming.		
	Case Studies	Live Video Streaming App, Video Transcoding App, Edge Computing, FOG Computing.		

	Self-Learning Topic	Green Cloud Computing, AI/ML Integration in Cloud Applications		
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Textbooks:

1. Cloud Computing - A Hands-on Approach - Arshdeep Bahga and Vijay K. Madiseti
2. Mastering Cloud Computing: Foundations and Applications Programming Paperback – by Rajkumar Buyya , Christian Vecchiola , S.Thamarai Selvi , Publisher: Morgan Kaufmann
3. Amazon Web Services For Dummies (For Dummies Series) Paperback by Bernard Golden, Publisher: John Wiley & Sons
4. “The Cloud Computing Book: The Future of Computing Explained” , Douglas E. Comer
5. Cloud Computing for Dummies, Judith Hurwitz Daniel Kirsch

Reference Books:

1. Cloud Computing Black Book : Kailash Jayaswal, Jagannath Kallakurchi, Donald J. Houde, Dr. Deven Shah by Kogent Learning Solutions , Publisher : Dreamtech Press
2. Cloud Computing Concepts Technology and Architecture - Erl second hand book online from UsedBooksFactory
3. Practical Cloud Security by Chris Dotson, Publisher(s): O'Reilly Media, Inc. ISBN: 9781492037514
4. AWS Whitepapers & Guides <https://aws.amazon.com/whitepapers/>
5. Azure whitepapers <https://azure.microsoft.com/en-in/resources/whitepapers/>
6. Google Cloud whitepapers <https://cloud.google.com/whitepapers>

Online References:

Sr. No.	Website Name
1.	1. NPTEL Swayam Course on Cloud computing By Prof. Soumya Kanti Ghosh https://nptel.ac.in/courses/106/105/106105167/
2.	2. Cloud Computing and Distributed Systems By Prof. Rajiv Misra https://onlinecourses.nptel.ac.in/noc22_cs18/preview
3.	3. Google Cloud Computing Foundation Course https://nptel.ac.in/courses/106/105/106105223

Self-Learning Topic Resource:

Module No.	Resource links for self-learning topic
1	https://youtu.be/_pB_YwwkMA by Prof. Rajiv Misra (IIT Kanpur)
2	https://www.youtube.com/watch?v=AkST9AO01x0

	https://www.youtube.com/watch?v=pVJHt4Tm IA by Prof. Rajiv Misra (IIT Kanpur)
3	https://www.scribd.com/document/920161763/Application-Services-Updated by Scribd Kailash Jayaswal, Jagannath Kallakurchi, Donald J. Houde, Deven Shah by Wiley India
4	https://www.youtube.com/watch?v=HXV3zeQKqGY by Free code camp
5	https://www.youtube.com/watch?v=M_9hRPVH5SA by Simplilearn
6	https://www.youtube.com/watch?v=nKQSD1SGncw by All About CSIT

Assessment:

Internal Assessment (IA) Test:

Assessment consists of two class tests of 20 marks each. The first class test (Internal Assessment I) is to be conducted when approximately 40% syllabus is completed, and the second class test (Internal Assessment II) when an additional 35% syllabus is completed. The duration of each test shall be one hour.

End-of-Semester Examination:

1. The question paper will comprise a total of 06 questions, each carrying 15 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and should cover maximum content of the entire syllabus.
4. Remaining questions will be randomly selected from all the modules as per the weightage of each module (which is proportional to number of respective lecture hours mentioned in the syllabus).

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
PCL501	Computer Communication Networks Laboratory	--	2	--	--	1	--	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Total				
PCL501	Computer Communication Networks Laboratory	--	--	--	--	25	--	25

Course Objectives:

1. To familiarize students with network devices, models, and layered architectures used in computer networks.
2. To develop competency in IP addressing, subnetting, and IPv4 network configuration.
3. To understand data link layer mechanisms, including framing, error control, and MAC protocols.
4. To analyze routing algorithms and implement static and dynamic routing protocols.
5. To examine transport layer protocols through TCP/UDP analysis and client-server communication.
6. To introduce application layer protocols and basic network security mechanisms through practical experimentation.

Course Outcomes:

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

1. Identify and explain the operation of network devices and protocol layers using simulations and packet analysis.
2. Apply IP addressing and subnetting techniques to configure and test IPv4 networks.
3. Demonstrate data link layer functions including framing, ARQ, and MAC protocol behavior.
4. Implement and compare routing algorithms and routing protocols in simulated networks.
5. Analyze TCP and UDP behavior including handshake, checksum, and performance characteristics.
6. Inspect application layer protocols and apply basic security techniques such as firewalling and encryption.

List of Experiments:

Week No	List of Experiments	Hrs.
01	Study of Network Devices To understand functions and differences of Hub, Switch, Router, and Gateway. Tools: Cisco Packet Tracer, and/ Real devices	02
02	OSI & TCP/IP Models To analyze packet flow across OSI and TCP/IP layers using diagrams. Tools: Cisco Packet Tracer, Wireshark	02
03	IP Addressing & Subnetting To solve Classful, CIDR, and VLSM subnetting problems. Tools: Manual calculation, Packet Tracer	02
04	ARQ Mechanisms To study Stop-and-Wait, Go-Back-N, and Selective Repeat protocols. Tools: Network simulator, Packet Tracer	02
05	MAC Protocols To analyze ALOHA and CSMA/CD behavior under traffic conditions. Tools: Packet Tracer, Simulator	02
06	IPv4 Configuration To configure IPv4 addresses and verify network connectivity. Tools: Packet Tracer, ping, ipconfig	02
07	Routing Algorithms To compare Distance Vector and Link State routing algorithms. Tools: Packet Tracer, GNS3	02
08	Routing Configuration To configure static routing and dynamic routing using RIP and OSPF. Tools: Packet Tracer, GNS3	02
09	ARP & ICMP Analysis To analyze ARP resolution and ICMP messages using packet capture. Tools: Wireshark, ping	02

10	TCP Handshake To observe and analyze TCP three-way handshake process. Tools: Wireshark	02
11	TCP vs UDP To compare performance characteristics of TCP and UDP protocols. Tools: Wireshark, Packet Tracer	02
12	Checksum Calculation To compute and verify TCP and UDP checksum fields. Tools: Wireshark, Manual calculation	02
13	Application Protocols To study HTTP, FTP, DNS, and SMTP packet exchange. Tools: Wireshark	02
14	Client–Server Communication To implement client–server programs using TCP and UDP sockets. Tools: C/Python socket programming	02
15	Firewall Configuration To configure basic firewall rules and packet filtering. Tools: Linux iptables, Packet Tracer	02

The laboratory experiments shall be performed using the above-mentioned open-source tools; however, any other suitable software or tools may also be used to carry out the specified experiments.

Assessment:

Term Work: Term Work shall consist of at least 10 practical's based on the above list.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 05 Marks (Assignments) + 5 Marks (Attendance).

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
PCL502	Electromagnetics and Antenna Lab	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Total				
PCL502	Electromagnetics and Antenna Lab	--	--	--	--	25	25	50

Prerequisites:

1. BSC201 Applied Mathematics-II
2. 2304113 Analog and Digital Communication

Course Objective:

1. To measure and analyze basic antenna parameters such as radiation pattern, gain, VSWR, and impedance.
2. To study radiation characteristics of dipole antennas, antenna arrays, and special antennas.
3. To design and evaluate microstrip and advanced antenna systems based on performance parameters.

Course Outcomes:

After successful completion of the course student will be able to

1. Measure and analyze basic antenna parameters such as radiation pattern, gain, directivity, beam width, VSWR, and impedance.
2. Analyze the radiation characteristics of dipole antennas and antenna arrays.
3. Evaluate the performance of special antennas such as Log-periodic, Yagi-Uda, and reflector antennas.
4. Design and characterize micro strip patch antennas based on performance parameters.
5. Explain and analyze the fundamental operating principles and performance parameters of advanced antenna systems.

List of Experiments.

Sr No	List of suggested Experiments	Hrs
01	Study different Antenna parameters (compulsory to use: FSM, Spectrum Analyzer and VNA)	02
02	Introduction to Different Antenna Types	02

03	Study of Wire Antenna, (Radiation pattern of dipole, folded dipole and Monopole antenna, various loops)	02
04	Study of Directive antenna, Yagi-Uda Antenna	02
05	Study of Broad-band Antenna, Log-periodic Antenna	02
06	Study of Antenna Arrays (Broadside, End-fire, Parametric study for various arrays parameters)	02
07	Study of Aperture Antennas (Parabolic/ Hyperbolic/ Horn , with or without Reflector)	02
08	Study of Regular shaped Microstrip Antenna	02
09	Study of advanced Antennas	02
10	Small Project report can be considered as a part of term-work (Design, Simulation and validation).	02

Sr No.	List of Suggested Assignments	Hrs
01	Problems on Coulomb's law and Gauss's law and applications, Biot Savart Law, Ampere Circuit law, Gauss's law for magnetic field	As per module
02	Maxwell's equation for time varying field, Boundary conditions, wave equation, Poynting theorem	
03	Antenna Parameters: Radiation pattern, radiation intensity, beam width, directivity, Gain, beam efficiency, bandwidth, polarization, Input impedance, Antenna efficiency, FRIT's transmission formula	
04	Derivation on Linear arrays of two isotropic point sources, linear arrays of N elements, Principle of pattern multiplication	
05	Design problem of MSA, Yagi Uda, Helix Antenna and types of horn antenna	
06	Case study on : MIMO, UWB, antenna used for 4G/5G application	
07	Case Study of Recent reported variations of Antenna types and the Radiation hazards (Paper from reputed journal is to be referred and thoroughly study and present the report, maximum four students per group)	

Textbooks:

1. Electromagnetic Waves and Radiating Systems- Jordan and Balmain, PHI, 2nd edition
2. Principles of Electromagnetics Engineering- Matthew N. O. Sadiku, S.V.Kulkarni, Oxford

University press, 6th edition

3. Antenna Theory: Analysis and Design, Costantine A. Balanis, John Wiley Publication, 4th Edition
4. Antenna and wave Propagation, John D Kraus, A S Khan, McGraw Hill, 4th edition
5. Antenna Theory and Design. Stutzman, Theile, John Wiley and Sons, 3rd edition

Reference Books:

1. Engineering Electromagnetics, William H Hayt and John A Buck, Tata McGraw-Hill Publishing Company Limited, 7th edition
2. Antennas and Radio Wave Propagation, R. E. Collin, McGraw Hill, International Student Edition
3. Electromagnetics with Applications, K. D. Prasad, New Age International (P) Limited, Publishers, 2nd edition.

Online Resources:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/108101092
2.	https://nptel.ac.in/courses/108105114

Assessment:

Term Work: Term Work shall consist of at least 08 to 10 practicals based on the above list. Also, Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment)
+ 5 Marks (Assignments) + 5 Marks (Attendance)

Practical& Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
PCL503	Discrete Time Signal Processing Laboratory	--	2	--	--	1	--	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Total				
PCL503	Discrete Time Signal Processing Laboratory	--	--	--	--	25	25	50

Laboratory 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

Laboratory Outcomes:

After successful completion of the course student will be able to

1. Compute and analyze discrete-time signals using convolution, correlation, DFT, and FFT for time- and frequency-domain representation.
2. Design IIR digital filters using analog filter approximations and s-plane to z-plane transformation techniques to meet given frequency specifications.
3. Design FIR digital filters using windowing and frequency sampling techniques and compare their characteristics with IIR filters.
4. Interpret and realize different realization structures of digital IIR and FIR filters.
5. Investigate the impact of finite word length and coefficient quantization on the performance of digital filters.
6. Apply digital signal processing concepts and algorithms to biomedical and audio signal processing applications

List of Experiments:

Week No	Module No	List of Experiments	CO
01	1	To perform linear convolution of two signals, auto correlation of non-periodic signals, periodic signals, and random noise and interpret the results obtained.	CO1
02	1	To linearly convolve the swept frequency sinusoidal wave with the LPF and HPF impulse response filters in the time domain and interpret the results obtained.	CO1
03	1	To obtain the cross-correlation of a signal with its delayed and attenuated version (Concept of radar signal processing).	CO1
04	2		CO2

		Compute DFT & FFT of discrete time signals & analyze their magnitude & phase spectra	
05	2	Perform linear and circular convolution of discrete-time sequences using the Discrete Fourier Transform.	CO2
06	1	To perform block convolution using overlap - add method and overlap-save method	CO1
07	2	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).	CO2
08	3	Design of FIR filter using windowing method 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.	CO3
09	3	Design of minimum phase, maximum phase and mixed phase systems	CO3
10	2	Design a Butterworth IIR digital filter for given specifications and analyze its frequency response and pole-zero plot.	CO2
11	2	Design a Chebyshev-I IIR digital filter for given specifications and analyze its frequency response and pole-zero plot.	CO2
12	3	Verify the location of zeros in symmetric and antisymmetric linear-phase FIR filters.	CO3
13	4	Realize a given IIR digital filter using cascade and parallel structures and compare their responses.	CO4
14	5	Perform coefficient quantization using truncation and rounding and study its effect on system output.	CO5
15	6	Implement echo cancellation for an audio signal using adaptive filtering techniques.	CO6
16	6	To generate Echo, Reverberation, Flanging effects in a sound signal.	CO6
17	6	DTMF tone generation and detection.	CO6
18	Application base experiment / Mini Project	Develop miniproject or software assignment based on real world DSP application	

List of Assignments:

Sr. No	List of Assignment/Tutorial	Hrs
01	Numerical problems on convolution and correlation	01
02	DFT and FFT computation problems	01
03	IIR and FIR filter design numericals	01
04	Short case study on DSP application (ECG / Speech)	01

Assessment:**Term Work:**

At least 08 experiments covering the entire syllabus must be given “Batch Wise” and implemented using any software, namely C, Python, Scilab, Matlab, Octave, etc. The experiments should be set to have well-defined inferences and conclusions. Application-oriented one-course one-project can be conducted for a maximum batch of four students. The teacher should refer to the suggested experiments and can design additional experiments to maintain better understanding and The experiments should be student-centric, and an attempt should be made to make experiments more meaningful, interesting, and innovative.

Term work assessment must be based on the overall performance of the student, with every experiment graded.

The grade must be converted to marks as per the credit and grading system manual, and should be added and averaged. Based on the above scheme, grading and term work assessment should be done. Practical and oral examinations will be based on the entire syllabus. Students are encouraged to share their experiment codes on an online repository. The practical exam slip should cover all 08 experiments for the examination.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 05 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
PEL5011	Data Compression and Cryptography Laboratory	--	2	--	--	1	--	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Total				
PEL5011	Data Compression and Cryptography Laboratory	--	--	--	--	25	25	50

Prerequisite:

1. VSEC202-Python Programming
2. 2303611-C++ and JAVA Programming

Laboratory Objectives: The course aims to

1. Introduce the principles of Data compression
2. Develop understanding of Text, Audio, Image and Video compression
3. Familiarize students about Cryptography algorithms

Laboratory Outcomes:

After successful completion of the course student will be able to

1. Understand the need for data compression
2. Analyse various encoding and decoding procedures for text compression
3. Apply compression algorithms for Audio, Image and Video
4. Secure data using Symmetric and Asymmetric Encryption Techniques
5. Apply number theory for Cryptography applications
6. Develop solutions for real-world applications

Suggested List of Experiments:

No	List of Experiments	LO
1	Find compression ratio after compression of various file formats like JPEG, TIFF, PNG and BMP.	1
2	Implement Minimum variance Huffman code Encoding and Decoding	2
3	Find the tag value of the given input sequence using Arithmetic Encoding	2
4	Generate codewords using Run length Encoding and also decode the codewords	2
5	Generate μ law and A law codewords for Audio compression.	3

6	Compress given image using Discrete Cosine Transform	3
7	Implement Substitution cypher using Caesar Cipher, Hill Cipher and Monoalphabetic cipher.	4
8	Implement and understand the working of Data Encryption Standard	4
9	Implement and understand the working of Advanced Encryption Standard	4
10	Prove Fermat's little Theorem and find Euler Totient Function	5
11	Find the inverse of a given number using Extended Euclid Algorithm	5
12	Find the primitive roots of a given prime number	5
13	Implement RSA Algorithm	6
14	Perform secret key exchange through Diffie Hellman Key Exchange algorithm	6
15	Implement SHA Algorithm	6
16	Hide text data in image using Steganography	6

Suggested List of Assignments / Tutorials:

Sr. No	List of Assignment / Tutorial	LO
01	Numerical on Text Compression	1
02	An overview of Audio Frames	2
03	Performance Analysis of various video compression approaches	3
04	Numerical on Substitution Cipher and Transposition Cipher	4
05	Numerical on Number Theory, RSA Encryption and Diffie Hellman Key exchange process	5
06	Case study on application of cryptography in real world problems	6

Assessment:

Term Work: Term Work shall consist of at least 08 experiments from the above suggested list or any other experiment based on syllabus will be included, which would help the learner to apply the concept learnt and 2 assignments/ tutorials based on the above suggested list or based on syllabus.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 05 Marks (Assignments/Tutorial) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held for 25 marks based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
PEL5012	Data Structure & Algorithms Lab	-	2	-	-	1	-	1

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
PEL5012	Data Structure & Algorithms Lab	--	--	--	--	--	25	25	50

Prerequisite:

VSEC102-C Programming Language

Course Objectives:

- 1 To implement basic data structures such as arrays, linked lists, stacks and queues
- 2 Solve problem involving graphs, and trees
- 3 To introduce the methods of designing and analyzing algorithms
- 4 Strengthen the ability to identify and apply the suitable algorithm for the given real-world problem.

Course Outcomes: At the end of Laboratory work, the students will be able to

- 1 Implement linear data structures & be able to handle operations like insertion, deletion, searching and traversing on them.
- 2 Implement nonlinear data structures & be able to handle operations like insertion, deletion, searching and traversing on them
- 3 Implement the algorithms using different approaches.
- 4 Analyze the complexities of various algorithms.

Sr. No	Title of the Experiment	LO
1	Implement Stack ADT using array.	LO1
2	Evaluate Postfix Expression using Stack ADT.	LO1
3	Implement Linear Queue ADT using array.	LO1
4	Implement Circular Queue ADT using array.	LO1
5	Implement Priority Queue ADT using array.	LO1
6	Implement Singly Linked List ADT.	LO1
7	Implement Circular Linked List ADT.	LO1
8	Implement Stack / Linear Queue ADT using Linked List.	LO1
9	Implement Binary Search Tree ADT using Linked List.	LO2
10	Implement Graph Traversal techniques (Any One) Depth First Search / Breadth First Search	LO2
11	Implement divide and conquer sorting technique (Merge Sort)	LO3, LO4
12	Single source shortest path- Dijkstra algorithm	LO3, LO4
13	Implement Rabin Karp algorithm	LO3, LO4
14	Implement Knuth-Morris-Pratt algorithm	LO3, LO4

Virtual Lab Links

1. DSA Virtual Lab (Student Project) **[Dsa Virtual Lab \(vppcoe-dsa-virtual-lab.vercel.app\)](https://vppcoe-dsa-virtual-lab.vercel.app)**
2. AlgoCraft DSA Visualizer **[AlgoCraft - Free Interactive Algorithm Visualization & DSA Learning Platform \(vikshalabs.in\)](https://vikshalabs.in)**
3. Free DSA Course (Great Learning) **[Virtual Lab Development - Interactive Learning Platform \(virtuallabsdev.netlify.app\)](https://virtuallabsdev.netlify.app)**

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practicals based on the above list. Also, Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
PEL5013	Machine Learning Laboratory	--	2	--	--	1	--	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Total				
PEL5013	Machine Learning Laboratory	--	--	--	--	25	25	50

Prerequisite:

1. VSEC202-Python Programming
2. 2304111-Neural Networks and Fuzzy Logic

Course Objectives: The course aims to

1. To understand correlation.
2. Develop understanding of regression model for real-world datasets and evaluate their performance using standard metrics.
3. Familiarize students about classification and clustering algorithms
4. Develop ML solutions for real world applications

Course Outcomes:

After successful completion of the course student will be able to

1. Analyse correlation matrix and identify the variables with positive correlation
2. Apply supervised learning techniques for regression tasks
3. Implement classification tasks using supervised learning techniques
4. Analyse and implement unsupervised learning for data exploration and pattern recognition.
5. Develop ML solutions for real-world applications

Suggested List of Experiments:

No	List of Experiments	LO
1	Develop a program to Compute the correlation matrix to understand the relationships between pairs of features. Visualize the correlation matrix using a heatmap to know which variables have strong positive/negative correlations.	1
2	Study and implement simple linear regression and multiple linear regression.	2
3	Study and implement polynomial regression	2
4	Develop a program to implement k-Nearest Neighbour algorithm to classify the randomly generated 100 values of x in the range of [0,1]. Perform the following based on dataset generated for k=1,2,3,4,5,20	3

	a. Label the first 50 points $\{x_1, \dots, x_{50}\}$ as follows: if $(x_i \leq 0.5)$, then $x_i \in \text{Class1}$, else $x_i \in \text{Class2}$ b. Classify the remaining points, $x_{51}, \dots, x_{100}$ using KNN.	
5	Develop a program to demonstrate the working of the decision tree algorithm. Use Breast Cancer Data set for building the decision tree and apply this knowledge to classify a new sample.	3
6	Develop a program to implement the Naive Bayesian classifier considering Olivetti Face Data set for training. Compute the accuracy of the classifier, considering a few test data sets.	3
7	Develop a program to demonstrate the working of the Random Forest algorithm	3
8	Write a program to implement SVM algorithm to classify the iris data set.	3
9	Evaluate a classification model using confusion matrix, precision, recall, F1-score, and ROC–AUC curve.	3
10	Develop a program to implement k-means clustering using Wisconsin Breast Cancer data set and visualize the clustering result	4
11	Develop a program to implement Principal Component Analysis (PCA) for reducing the dimensionality of the Iris dataset from 4 features to 2.	4
12	Implement Linear Discriminant Analysis (LDA) for dimensionality reduction and compare it with PCA.	4
13	Perform Sentiment Analysis using machine learning	5
14	Perform email spam detection using machine learning	5
15	Predict the presence of a disease (e.g., diabetes or heart disease) using patient medical data.	5

Suggested List of Assignments:

Sr. No	List of Assignment/Tutorial	LO
01	Predictive Analysis in machine learning	5
02	Machine learning in medical applications	5
03	Use of machine learning for Agricultural Applications	5
04	Dimensionality Reduction using PCA and LDA	5
05	Explain with an example Q learning in Reinforcement Learning	5

Assessment:

Term Work: Term Work shall consist of at least 08 practical and 2 assignments based on the above suggested list.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 05 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held for 25 marks based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
PEL5014	Cloud Computing & Security Lab	--	2	--	--	1	--	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg. of 2 Tests				
PEL5014	Cloud Computing & Security Lab	--	--	--	--	25	25	50

Course Objectives:

1. To make students familiar with key concepts of virtualization.
2. To make students familiar with various deployment models of cloud such as private, public, hybrid and community so that they start using and adopting appropriate type of cloud for their application.
3. To make students familiar with various service models such as IaaS, SaaS, PaaS, Security as a Service (SECaaS) and Database as a Service.
4. To make students familiar with security and privacy issues in cloud computing and how to address them.

Course Outcomes:

After successful completion of the course student will be able to

1. Implement different types of virtualization techniques.
2. Analyze various cloud computing service models and implement them to solve the given problems.
3. Design and develop real world web applications and deploy them on commercial cloud(s).
4. Explain major security issues in the cloud and mechanisms to address them.
5. Explore various commercially available cloud services and recommend the appropriate one for the given application.
6. Implement the concept of containerization

List of Experiments:

Week No	List of Experiments	Hrs
01	Title: Introduction and overview of cloud computing. Objective: To understand the origin of cloud computing, cloud cube model, NIST model, characteristics of cloud, different deployment models, service models, advantages and disadvantages.	02
02	Title: To study and implement Hosted Virtualization using Virtual Box & KVM. Objective: To know the concept of Virtualization along with their types, structures and mechanisms. This experiment should have demonstration of creating and running Virtual machines inside hosted hypervisors like Virtual Box and KVM with their comparison based on various virtualization parameters.	02
03	Title: To study and Implement Bare-metal Virtualization using Xen, HyperV or VMware Esxi. Objective: To understand the functionality of Bare-metal hypervisors and their relevance in cloud computing platforms. This experiment should have demonstration of install, configure and manage Bare Metal hypervisor along with instructions to create and run virtual machines inside it. It should also emphasize on accessing VMs in different environments along with additional services provided by them like Load balancing, Auto-Scaling, Security etc.	02
04	Title: To study and Implement Infrastructure as a Service using AWS/Microsoft Azure. Objective: To demonstrate the steps to create and run virtual machines inside Public cloud platform. This experiment should emphasize on creating and running Linux/Windows Virtual machine inside Amazon EC2 or Microsoft Azure Compute and accessing them using RDP or VNC tools.	02
05	Title: To study and Implement Platform as a Service using AWS Elastic Beanstalk/ Microsoft Azure App Service. Objective: To demonstrate the steps to deploy Web applications or Web services written in different languages on AWS Elastic Beanstalk/ Microsoft Azure App Service.	02
06	Title: To study and Implement Storage as a Service using Own Cloud/ AWS S3, Glaciers/ Azure Storage. Objective: To understand the concept of Cloud storage and to demonstrate the different types of storages like object storage, block level storages etc. supported by Cloud Platforms like Own Cloud/ AWS S3, Glaciers/ Azure Storage.	02
07	Title: To study and Implement Database as a Service on SQL/NOSQL databases like AWS RDS, AZURE SQL/ Mongo DB Lab/ Firebase. Objective: To know the concept of Database as a Service running on cloud and to demonstrate the CRUD operations on different SQL and NOSQL databases running on cloud like AWS RDS, AZURE SQL/ Mongo Lab/ Firebase.	02
08	Title: To study and Implement Security as a Service on AWS/Azure Objective: To understand the Security practices available in public cloud platforms and to demonstrate various Threat detection, Data protection and Infrastructure protection services in AWS and Azure.	02

09	Title: To study and implement Identity and Access Management (IAM) practices on AWS/Azure cloud. Objective: To understand the working of Identity and Access Management IAM in cloud computing and to demonstrate the case study based on Identity and Access Management (IAM) on AWS/Azure cloud platform.	02
10	Mini-project: Design a Web Application hosted on public cloud platform [It should cover the concept of IaaS, PaaS, DBaaS, Storage as a Service, Security as a Service etc.]	02

Important Resources:

Sr. No.	Topic	Link
1	Introduction and overview of cloud computing	https://www.nist.gov/system/files/documents/itl/cloud/NIST_SP-500-291_Version2_2013_June18_FINAL.pdf
2	Hosted Virtualization using KVM	https://phoenixnap.com/kb/ubuntu-installkvm\
3	Bare metal Virtualization using Xen	https://docs.citrix.com/en-us/xenserver/7-1/install.html
4	IaaS, PaaS, STaaS, DbaaS, IAM and Security as a Service on AWS and Azure	1) AWS https://docs.aws.amazon.com/ 2) MS Azure https://docs.microsoft.com/en-us/azure

Assessment:

Term Work: Term Work shall consist of at least 8 to 10 practicals based on the above list.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 05 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.