AC –
Item No. –

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. (Electronics & Telecommunication)**
2	**Exit Degree**	**B.Sc. Tech Engineering (Electronics & Telecommunication).**
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/-	**Sd/-**	**Sd/-**
Dr. Faruk Kazi	**Dr. Deven Shah**	**Prof. Shivram S. Garje**
BoS-Chairman- Electronics and Telecommunication Engineering	**Associate Dean**	**Dean**
Faculty of Technology	**Faculty of Science & Technology**	**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.

Sd/-	**Sd/-**	**Sd/-**
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Faculty of Technology	**Faculty of Science & Technology**	**Faculty of Science & Technology**

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**							
	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	
	R:_____D									
5.5	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	**B.Sc. Tech Engineering (Electronics & Telecommunication) 48**
	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

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

Detail Syllabus

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).

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, FRII'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 Planner 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, 4thEdition
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

Assessment:

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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.

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.

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. Rajsekaran. "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		

Textbooks:

1. Cloud Computing - A Hands-on Approach - Arshdeep Bahga and Vijay K. Madisetti
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_lA 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 filed, 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, FRII'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)**

2. AlgoCraft DSA Visualizer **AlgoCraft - Free Interactive Algorithm Visualization & DSA Learning Platform (vikshalabs.in)**

3. Free DSA Course (Great Learning) **Virtual Lab Development - Interactive Learning Platform (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 {x1,……,x50} as follows: if (xi ≤ 0.5), then xi ∈ Class1, else xi ∈ Class1 b. Classify the remaining points, x51,……,x100 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 star 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.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
PCC601	Image Processing and Machine Vision	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					
PCC601	Image Processing and Machine Vision	20	20	40	60	2	--	--	100

Prerequisite:

1. 2303111-Mathematics for Signal Analysis
2. PCC503-Discrete Time Signal Processing
3. VSEC202-Python Programming

Course Objectives:

1. To teach the fundamentals and mathematical models in digital image processing and Machine Vision.
2. To teach quality enhancement of image through filtering operations.
3. To teach the students image morphology and restoration techniques.
4. To expose the students to segmentation techniques in image processing and Machine Vision.
5. To teach the techniques of extracting image attributes like regions and shapes.
6. To learn classification and recognition algorithms for machine vision.

Course Outcomes:

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

1. Understand fundamentals of image processing and machine vision.
2. Enhance the quality of image using spatial and frequency domain techniques for image enhancement.
3. Learn image morphology and restoration techniques.
4. Learn image segmentation techniques based on principle of discontinuity and similarity using various algorithms.
5. Represent boundaries and shapes using standard techniques.
6. Classify the object using different classification methods.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours
0	**Prerequisite**	-	**-**
I	**Digital Image Fundamentals and Point Processing**	• Introduction –Steps in Digital Image Processing, concept of spatial and intensity resolution, Relationships between pixels • Point Processing : Image Negative, Log Transform, Power Law transform, Bit plane slicing, Contrast stretching , Histogram equalization and Histogram Specification	**4**
II	**Image Enhancement**	• Spatial Domain filtering: The Mechanics of Spatial Filtering, Smoothing Spatial Filters-Linear Filters-Averaging filter, Order-Statistic Filters- Median filter, Application of Median filtering for Noise removal Sharpening Spatial Filters- The Laplacian, Unsharp Masking and Highboost Filtering, Using First-Order Derivatives — The Gradient- Sobel, Prewitt and Roberts • Frequency Domain Filtering: Introduction to 2-D DFT and its application in frequency domain filtering, Wavelet transform, Haar transform • Frequency Domain Filtering Fundamentals, Fourier Spectrum and Phase angle, Steps for Filtering in the Frequency Domain, Correspondence Between Filtering in the Spatial and Frequency Domains, Frequency domain Image Smoothing and sharpening filter - Ideal, Butterworth , Gaussian	**8**
III	**Image Morphology and Restoration**	• Morphology: Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transformation, Boundary extraction, Hole filling, Thinning and thickening • Restoration : A Model of the Image Degradation/Restoration Process, Noise models, Removal periodic noise, Principle of Inverse filtering	**6**
IV	**Image Segmentation**	• Point, Line, and Edge Detection: Detection of Isolated Points, Line detection, edge models, Canny's edge detection algorithm, Edge linking: Local processing and boundary detection using regional processing (polygonal fitting) • Thresholding: Foundation, Role of illumination and	**8**

		reflectance, Basic global thresholding • Region Based segmentation: Region Growing, Region Splitting and merging	
V	**Introduction to Machine Vision and Descriptors**	• Principle of machine vision, real world applications, chain code, simple geometric border representation, Fourier Transform of boundaries, Boundary description using segment sequences • Introduction to Texture, co-occurrence matrix	**5**
VI	**Machine Vision Algorithms**	• Knowledge representation, Classification Principles, Classifier setting, Classifier Learning, Confusion Matrix • K-means clustering algorithm, Introduction, bays decision theory continuous case, two category classification, Bayesian classifier, Support vector machine	**8**

NOTE: Teacher can assign some self-learning topics relevant to each module.

Textbooks:

1. Milan Sonka, Vaclav Hlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision" Cengage Engineering, 3rd Edition, 2013.
2. Gonzales and Woods, "Digital Image Processing", Pearson Education, India, Third Edition.
3. R. O. Duda and P. E. hart, Pattern classification and scene analysis, Wiley Interscience publication.
4. Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006.

Reference Books:

1. Anil K.Jain, "Fundamentals of Image Processing", Prentice Hall of India, First Edition, 1989.
2. W Pratt, "Digital Image Processing", Wiley Publication, 3rd Edition, 2002.
3. Forsyth and Ponce, Computer vision: A modern approach, PHI.
4. Frank Y Shish ,Image Processing and Pattern Recognition: Fundamentals and Techniques, Wiley Wiley-IEEE Press, 2010.

Online References:

Sr. No.	Website Name
1.	Swayam: Computer Vision and Image Processing - Fundamentals And Applications By Prof. M. K. Bhuyan, IIT Guwahati. https://onlinecourses.nptel.ac.in/noc26_ee31/preview
2.	Coursera: Introduction to Computer Vision and Image Processing Instructors: Aije Egwaikhide and Joseph Santarcangelo

	https://www.coursera.org/learn/introduction-computer-vision-watson-opencv

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	Tutorial	Theory	Practical	Tutorial	Total
PCC602	Digital VLSI	3	–	–	3	–	–	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hours)			
		Test 1	Test 2	Total					
PCC602	Digital VLSI	20	20	40	60	2	—-	—-	100

Course Pre-requisite:

1. 2303112-Electronic Devices and Linear Circuits
2. 2303113-Digital System Design

Course Objectives:

1. To understand the fundamentals, operation, and characteristics of MOSFETs used in VLSI design.
2. To understand the operation and performance parameters of various CMOS inverter circuits.
3. To understand different MOS logic styles for designing combinational and sequential circuits.
4. To understand the operations of various semiconductor memories.
5. To understand various datapath components for efficient VLSI system design.
6. To provide an exposure to RTL design, HDL programming, and FPGA implementation.

Course Outcomes:

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

1. Explain the MOSFET operation and characteristics for VLSI applications.
2. Compare CMOS inverters based on performance parameters such as delay, power, and noise margins.
3. Design combinational and sequential circuits using different MOS logic styles.
4. Design various semiconductor memories
5. Analyze datapath components based on performance metrics.
6. Design, implement, and verify combinational/sequential circuits using HDL on FPGA platforms.

DETAILED SYLLABUS

Module No.	Unit No.	Details of Module	Hours	CO Mapping
1.0		**Fundamentals of MOSFETs**	**08**	**CO1**
	1.1	Review of MOSFET operation, characteristics, Threshold voltage, drain current equation, MOSFET Capacitances, MOSFET scaling, Short channel effects.	04	
	1.2	Fabrication process flow of NMOS and CMOS, Stick Diagram, Lambda-based design rules.	02	
	1.3	Novel MOSFET Architectures FinFET, GAA-FET, CNTFET.	02	
2.0		**Combinational CMOS Logic Circuits**	**09**	**CO2**
	2.1	Types of Inverter (Resistive load, NMOS load (E and D type), Static CMOS.	02	
	2.2	CMOS inverter operation, Voltage Transfer characteristics (VTC), Noise Margins, Propagation Delay, Power Dissipation, Design of CMOS Inverter, Layout of CMOS Inverter.	04	
	2.3	Realization of CMOS NAND gate, NOR gate and any Boolean expression, Transistor sizing, Layout of CMOS NAND, NOR gate.	03	
3.0		**MOS Design Logic Styles**	**08**	**CO3**
	3.1	Pass Transistor Logic, Transmission Gate, Pseudo NMOS, Dynamic Logic, Domino Logic, NORA, Zipper, C2MOS.	04	
	3.2	Realization of Boolean expression, Shift Register, MUX, Decoder using the above design styles.	02	
	3.3	Clocked CMOS SR Latch, CMOS JK Latch, Edge-triggered D-Flip Flop and realization using design styles.	02	
4.0		**Semiconductor Memories**	**05**	**CO4**
	4.1	ROM array, 6T-SRAM (operation, design strategy, leakage currents, sense amplifier).	03	
	4.2	Operation of 1T and 3T DRAM Cell, NAND and NOR flash memory.	02	
5.0		**Data path Design**	**06**	**CO5**
	5.1	Ripple carry adder, CLA adder, carry save adder, carry select adder, carry skip adder.	04	

	5.2	Array Multiplier and Barrel Shifter	02	
6.0		**RTL Design and FPGA Implementation**	**03**	**CO6**
	6.1	High-level state machines, RTL design of Laser-Based Distance Measurement and Soda dispenser machine.	02	
	6.2	Implementation of combinational and sequential circuits using HDL on FPGA board.	01	
		Total	**39**	

Text Books:

1. Sung-Mo Kang and Yusuf Leblebici, "CMOS Digital Integrated Circuits Analysis and Design", Tata McGraw Hill, 3rd Edition, 2012.
2. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, "Digital Integrated Circuits: A Design Perspective", Pearson Education, 2nd Edition.
3. Frank Vahid, "Digital Design with RTL design, VHDL and VERILOG", John Wiley and Sons Publisher 2011.
4. D. L. Perry, "*VHDL: Programming by Example"*, 4th ed. New York, USA: McGraw-Hill, 2002.

Reference Books:

1. Neil H. E. Weste, David Harris and Ayan Banerjee, ―CMOS VLSI Design: A Circuits and Systems Perspective‖, Pearson Education, 3rd Edition.
2. John P. Uyemura, "Introduction to VLSI Circuits and Systems", Wiley, Student Edition, 2013.
3. R. Jacob Baker, "CMOS Circuit Design, Layout and Simulation", Wiley, 2nd Edition, 2013
4. S. Palnitkar, *"Verilog HDL: A Guide to Digital Design and Synthesis"*, 2nd ed. SunSoft Press, 2003.

NPTEL / Swayam Course:

1. https://nptel.ac.in/courses/117/101/117101058/
2. https://nptel.ac.in/courses/108/107/108107129/
3. https://nptel.ac.in/courses/117106092
4. https://onlinecourses.nptel.ac.in/noc21_ee09/preview
5. https://onlinecourses.nptel.ac.in/noc25_cs25/preview

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 approx. 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-Semester Examination:

1. The question paper will comprise of 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 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
PEC6011	Database Management Systems	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					
PEC6011	Database Management Systems	20	20	40	60	2	--	--	100

Rationale:

In today's data-driven world, Database Management Systems (DBMS) play a vital role in the efficient storage, organization, and analysis of data. This course provides students with a strong foundation in database concepts, data modelling, relational theory, and SQL, along with skills in normalization, transaction management, concurrency control, and recovery mechanisms. The course also introduces modern NoSQL databases, enabling students to understand and apply appropriate data management solutions across diverse and large-scale application domains

Prerequisite:

1. VSEC102-C Programming
2. 2303611-Skill Lab :- C++ and Java Programming
3. VSEC202-Python Programming

Course Objectives:

Sr.No	Course Objective
1	To introduce students to the fundamental concepts, architecture, and components of database management systems.
2	To develop students' ability to create ER/EER data models and map them to relational databases.
3	To familiarize students with relational algebra concepts and to develop skills in formulating SQL queries for data definition, manipulation, and retrieval
4	To provide an understanding of database normalization techniques for designing efficient and redundancy-free database structures.
5	To explain the concepts of transaction management, concurrency control, and recovery mechanisms for maintaining database consistency and reliability.
6	To introduce students to NoSQL database systems and their applications in modern, distributed, and large-scale data environments.

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

- **CO1** Understand fundamental concepts of databases and apply data modelling techniques for database design
- **CO2** Apply relational database concepts and mapping rules to construct a relational model from a data model and formulate relational algebra queries
- **CO3** Formulate and execute SQL queries for data definition, manipulation, and retrieval
- **CO4** Analyze and normalize database schemas up to Fifth Normal Form (5NF) to ensure data integrity and eliminate redundancy
- **CO5** Understand transaction management and concurrency control mechanisms to maintain database consistency and reliability, as well as recovery techniques to analyze conflict in multiple transactions
- **CO6** Describe NoSQL databases and evaluate their role in modern, large-scale, and distributed applications

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	**Prerequisite**	Basic knowledge of data structures, Fundamentals of the computer system	-	-
I	**Introduction to Database and Data Modelling**	• Introduction to data, database and database management system • Database system concepts and applications • File system vs Database system • Characteristics of Database • DBMS architecture • Three-Tier Database Architecture • Database users • Roles and Responsibilities DBA • Importance of Data Models • Introduction to various data models (Hierarchical, Network, ER and Object Model) • Basic Building Blocks and Business Rules • Data Abstraction and Data Independence	**4**	**CO1**
	Self-Study Topic	1. Evolution of Database Systems (from file-based to NoSQL era) 2. Role of DBA in modern organizations (tools & responsibilities) 3. **Case study:** Comparison of 2-tier vs 3-tier architecture 4. Advantages of Data Independence in Modern Databases 5. Business Rules and Constraints – Case		

		study on Library or Hospital DBMS		
	Key Skills Developed	1. Understanding fundamental concepts of data, database, and DBMS. 2. Ability to differentiate file-based systems from database systems. 3. Comprehension of DBMS architecture and 3-tier models. 4. Identifying roles and responsibilities of Database Administrators (DBA). 5. Interpreting and designing data models such as Hierarchical, Network, ER, and Object models. 6. Understanding of data abstraction, data independence, and business rules.		

II	**Database Design, Relational Model and Relational Algebra**	• Relational model concepts
		• Relation, tuple, attribute, domain
		• Keys: Super key, candidate key, primary key, foreign key
		• Integrity constraints, key Constraint, Domain Constraints (Null and Default),referential constraints, Check Constraints
		• Entity–Relationship (ER) Model
		  ○ Entity, attributes, relationships
		  ○ Strong and weak Entity set
		  ○ Types of attributes
		  ○ Keys and types of keys
		  ○ Cardinality and participation constraints
		• ER Diagram Issues
		• Mapping ER model to Relational Model
		• ER diagrams and examples
		• Extended Entity-Relationship (EER) Model:
		  ○ Generalization,
		  ○ Specialization and
		  ○ Aggregation
			6	**CO2**

		• Codd‘s rules, Relational Schemas,
		• Relational Database design:
		  o features of good relational database design,
		  o atomic domain
		• Relational Algebra:
		  o Selection(σ),Projection(π), Union(U),
		  o Set difference(-), Cartesian product (x), Divison(÷)
		  o Rename (ρ)
		  o Join operations (⋈)
		  o (Inner Joins natural, equi, theta outer joins)
		  o Relational Algebra Queries		

	Self-Study Topics	1. Mapping ER Model to Relational Schema – step-by-step example 2. Case study: Designing an ER diagram for a college admission system 3. Extended ER Concepts (Specialization, Generalization, Aggregation) – examples 4. Codd’s 12 Rules – Practical examples using modern RDBMS 5. Writing and executing basic Relational Algebra queries using examples		
	Key Skills Developed	1. Designing Entity-Relationship (ER) diagrams and converting them to relational schemas. 2. Understanding and applying relational model concepts: attributes, tuples, domains, and keys. 3. Applying integrity constraints for data accuracy and consistency. 4. Using relational algebra operators for query formulation and optimization. 5. Understanding and applying Codd’s rules and relational schema design principles. 6. Evaluating EER concepts (specialization, generalization, aggregation). 7. Developing logical database designs that support real-world applications.		
III	**Structured Query Language (SQL) and**	• SQL overview and architecture • SQL Data Types • DDL commands: CREATE, ALTER, DROP, TRUNCATE	**10**	**CO3**

	PLSQL	• DML commands: INSERT, UPDATE, DELETE, SELECT
		• Constraints: PRIMARY KEY, FOREIGN KEY, UNIQUE, CHECK, NOT NULL
		• Aggregate functions and WHERE, GROUP BY, HAVING, ORDER BY,
		• Key and Different types
		• Joins and subqueries
		• String, Maths and DateTime Functions
		• String Operations
		• Views
		  ○ Operation on Views
		  ○ Comparison of view and tables
		• Triggers
		• Introductions to Cursors
		• Introduction to PL/SQL
		  ○ Blocks, variables,
		  ○ control structures (Branch and loops)
		  ○ Functions and Procedures		

	Self-Study Topics	1. Nested Subqueries and Correlated Queries 2. Implementation of Triggers in Oracle/MySQL 3. Use of Cursors in PL/SQL – example programs 4. Creating and using User-Defined Functions and Stored Procedures 5. Views in SQL – advantages and limitations 6. Case study: Implementation of DDL, DML, and DCL commands for a small database 7. Exploring aggregate functions with GROUP BY and HAVING		
	Key Skills Developed	1. Writing and executing SQL queries using DDL, DML, and DCL commands. 2. Designing and managing database objects such as tables, views, and constraints. 3. Implementing joins, subqueries, and aggregate functions to solve data problems. 4. Developing stored procedures, functions, and triggers using PL/SQL. 5. Applying control structures (loops, conditionals) in PL/SQL programs. 6. Implementing business logic using cursors, triggers, and functions. 7. Enhancing problem-solving and logical thinking for data manipulation and		

		retrieval.		
IV	**Database Normalization**	• Importance/Need of Normalization • Pitfalls in Relational Database Design • Anomalies and Types of Anomalies • Functional dependency • Types of dependencies • First Normal Form (1NF) • Second Normal Form (2NF) • Third Normal Form (3NF) • Boyce–Codd Normal Form (BCNF) • Fourth Normal Form (4NF) • Fifth Normal Form (5NF) • Lossless and dependency-preserving decomposition	**6**	**CO4**
	Self-Study Topic	1. Stepwise normalization of a sample unnormalized table 2. Functional Dependencies – case study examples 3. Difference between 4NF and 5NF with example tables 4. Dependency Preserving and Lossless Decomposition – numerical examples 5. Case study: Normalization of Student/Employee Database		
	Key Skills Developed	1. Analyzing data redundancy and anomalies in database design. 2. Applying normalization principles (1NF to 5NF) to improve database structure. 3. Understanding and using functional dependencies in schema design. 4. Performing decomposition while preserving dependency and lossless properties. 5. Evaluating trade-offs between normalization and performance. 6. Designing normalized databases for real-life systems such as banking or library databases.		
V	**Transaction Management and Concurrency Control**	• Transaction concepts • ACID properties • Transaction states • Schedules and Serializability • Conflict and View serializability	**6**	**CO5**

		• Concurrency control problems
		• Lock-based protocols
		  ○ Shared and exclusive locks
		  ○ Two-phase locking (2PL)
		• Deadlock
		  ○ Detection, prevention and Handling
		• Recovery management
		  ○ Commit, rollback, checkpoints
		  ○ Database Recovery Management		

	Self-Study Topic	1. Implementation of ACID properties using SQL Transactions 2. Examples of Serial, Non-serial, and Serializable Schedules 3. Conflict and View Serializability – illustrative problems 4. Deadlock in Database Systems – detection and prevention techniques 5. Implementation of Lock-based Protocols (Shared & Exclusive Locks) 6. Role of Checkpoints and Recovery Management 7. Case study: Transaction management in Online Banking System		
	Key Skills Developed	1. Understanding transaction properties (ACID) and their significance in DBMS. 2. Applying transaction concepts to maintain data consistency. 3. Analyzing concurrency control issues and applying lock-based mechanisms. 4. Detecting and resolving deadlocks in multi-user environments. 5. Implementing recovery techniques (commit, rollback, checkpoint). 6. Understanding scheduling, serializability, and conflict resolution in concurrent transactions. 7. Building awareness of fault-tolerant and reliable database systems.		

VI	**NoSQL Databases**	• Limitations of relational databases
		• Introduction to NoSQL databases
		• Characteristics of NoSQL
		• Types of NoSQL databases:
		  ○ Key-value stores
		  ○ Document databases
		  ○ Column-oriented databases
			7	**CO6**

		○ Graph databases • CAP theorem • CRUD Operation on NoSQL • Comparison: SQL vs NoSQL • Applications of NoSQL in Big Data and IoT		
	Self-Study Topic	1. CAP Theorem – proof and implications in distributed databases 2. Comparison between SQL and NoSQL with examples (MySQL vs MongoDB) 3. CRUD Operations in NoSQL using MongoDB shell commands 4. Case study: Using Document Databases in E-commerce applications 5. Column-oriented Databases (e.g., Cassandra, HBase) – architecture and use 6. Graph Databases (Neo4j) – concept and Cypher queries 7. Applications of NoSQL in Big Data and IoT systems 8. BASE vs ACID properties in NoSQL		
	Key Skills Developed	1. Understanding the limitations of traditional RDBMS for unstructured data. 2. Exploring the principles and architecture of NoSQL databases. 3. Classifying NoSQL databases: Key-Value, Document, Column, and Graph-based. 4. Applying CRUD operations using NoSQL tools (e.g., MongoDB). 5. Understanding CAP theorem and its trade-offs in distributed systems. 6. Comparing SQL vs. NoSQL performance and use-cases. 7. Exploring real-world applications of NoSQL in Big Data and IoT systems.		
	Overall Skill Developed	• **Analytical Skills:** Database design, normalization, and optimization. • **Technical Skills:** SQL/PLSQL programming, query writing, and data manipulation. • **Design Skills:** ER and EER modelling for complex systems. • **Problem Solving:** Handling concurrency, transactions, and recovery scenarios. • **Industry Relevance:** Exposure to real-world data models, NoSQL, and Big Data		

		concepts.		

Textbooks

1. Ramez Elmasri and Shamkant B. Navathe, ***Fundamentals of Database Systems***, 7th Edition, Pearson Education.
2. Abraham Silberschatz, Henry F. Korth, and S. Sudarshan, ***Database System Concepts***, 7th Edition, McGraw-Hill.
3. Raghu Ramakrishnan and Johannes Gehrke, ***Database Management Systems***, Tata McGraw-Hill.
4. G. K. Gupta, ***Database Management Systems***, McGraw-Hill Education.
5. Peter Rob and Carlos Coronel, ***Database Systems: Design, Implementation, and Management***, Cengage Learning.
6. Rajkumar Buyya, Christian Vecchiola, and S. Thamarai Selvi, ***Mastering Cloud Computing,*** Tata McGraw-Hill Education.
7. Kristina Chodorow, ***MongoDB: The Definitive Guide,*** **3rd Edition**, O'Reilly Media. *(For NoSQL)*

Reference Books

1. Dr. P. S. Deshpande, ***SQL and PL/SQL for Oracle 10g/11g, Black Book***, Dreamtech Press.
2. Mark L. Gillenson and Paulraj Ponniah, ***Introduction to Database Management***, Wiley.
3. C. J. Date, ***An Introduction to Database Systems***, 8th Edition, Addison-Wesley.
4. Hector Garcia-Molina, Jeff Ullman, and Jennifer Widom, ***Database Systems: The Complete Book,*** Pearson Education.
5. Debabrata Sahoo, ***Database Management Systems (Schaum's Outline),*** Tata McGraw-Hill.
6. Pramod J. Sadalage and Martin Fowler, ***NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence,*** Addison-Wesley.
7. Rick F. van der Lans, ***Introduction to SQL: Mastering the Relational Database Language,*** Addison-Wesley.

E-Resources:

SrNo	URLs
1	**NPTEL — DBMS (IIT Professors)**
	Comprehensive video lectures covering DBMS fundamentals, data models, design, SQL, transactions. https://nptel.ac.in/course/106/106/106106169/
2	**Coursera — IBM DBMS & SQL Specialization**
	Industry-aligned courses with quizzes and projects (certificate available). https://www.coursera.org/specializations/ibm-database-systems
3	**Oracle Academy**
	Free courses on SQL, PL/SQL, database concepts, and database design; hands-on Oracle

	labs. https://academy.oracle.com/en/oa-web-overview.html
4	**MongoDB University — NoSQL Courses**
	Official platform for learning MongoDB with guided labs (free). https://university.mongodb.com/
5	**edX — Databases: Relational Database Concepts (Stanford)**
	Free university-level course on relational databases (audit mode). https://www.edx.org/course/databases-5-sql
6	**Khan Academy — Intro to SQL**
	Interactive SQL tutorials with practice exercises (great for beginners). https://www.khanacademy.org/computing/computer-programming/sql
7.	**W3Schools — SQL Tutorial**
	Beginner-friendly reference with examples, live editor, and quizzes. https://www.w3schools.com/sql/
8	**Udemy — SQL & PL/SQL Courses**
	Paid but highly practical courses (often discounted). https://www.udemy.com/topic/sql/
9	**YouTube – Free DBMS Playlists** Topic-wise DBMS tutorials in video format (ER, relational algebra, SQL):
	• *Gate Smashers DBMS* https://www.youtube.com/c/GateSmashersOfficial • *MySirG SQL & PL/SQL* https://www.youtube.com/c/MySirG
10	**TutorialsPoint — DBMS & SQL**
	Text tutorials with examples, definitions, and practice questions. https://www.tutorialspoint.com/dbms/index.htm https://www.tutorialspoint.com/sql/index.htm

Self-Learning Case Studies: Suggested Case Studies (Any such cases can be selected by the teacher)

1. Library Management System
2. Hospital Management System
3. Pharmacy Management System
4. Human Resource Database Management System
5. Students Database Management System
6. Employee Management System
7. Inventory Control Management System
8. College Management System
9. University Management System

10. Customer Relationship Management System
11. Online Shopping Management System
12. Railway, Airways Management System

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.

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 the 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 the 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
PEC6012	Analysis of Algorithm	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					
PEC6012	Analysis of Algorithm	20	20	40	60	2	--	--	100

Prerequisite: -

Course Objectives:

1. To provide mathematical approaches for Analysis of Algorithms
2. To understand and solve problems using various algorithmic approaches
3. To analyze algorithms using various methods

Course Outcomes:

1. Analyze the time and space complexity of algorithms.
2. Describe, apply and analyze the complexity of divide and conquer strategy.
3. Describe, apply and analyze the Greedy algorithm approach and determine its efficiency.
4. Describe, apply and analyze Dynamic Programming and examine its complexity.
5. Explain and apply Backtracking and Branch and Bound techniques.
6. Explain and apply String Matching algorithms for pattern searching.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	C programming basic concepts	1	
I	Introduction	Performance analysis, space, and time complexity Growth of function, Big- Oh, Omega, Theta Notation Mathematical background for algorithm analysis. Analysis of selection sort, insertion sort. Recurrences: The substitution method, Master method **Self-learning Topics:** Recursion tree method, Complexity class: Definition of P, NP, NP-Hard, NP-Complete (Link- https://www.youtube.com/watch?v=eOrxeu3GNrI) (https://www.youtube.com/watch?v=0yHYbz-Hec8)	6	CO1
II	Divide and Conquer Approach	General method, Merge sort, Quick sort, Analysis of Linear Search and Binary search **Self-learning Topics:** Finding minimum and maximum algorithms and their Analysis(http://youtube.com/watch?v=Vus2I9NVNzc&t=925s), Strassen's Algorithm(https://www.youtube.com/watch?v=_	6	CO2

		onMSkbVvuY&t=121s), real life applications of all algorithms		
III	**Greedy Method Approach**	General Method, Single source shortest path: Dijkstra Algorithm, Fractional Knapsack problem, Minimum cost spanning trees: Kruskal and Prim's algorithms **Self-learning Topics:** Job sequencing with deadlines, real life applications of all algorithms(https://www.youtube.com/watch?v=HsrODlTYgrM&t=2566s)	**7**	CO3
IV	**Dynamic Programming Approach**	General Method, Multistage graphs, All pair shortest path: Floyd Warshall Algorithm, 0/1 knapsack Problem, Travelling Salesperson problem, Longest common subsequence. **Self-learning Topics:** Bellman Ford Algorithm(https://www.youtube.com/watch?v=akSZSgPsyGE&t=79s), real life applications of all algorithms	**8**	CO4
V	**Backtracking and Branch and bound**	General Method, Backtracking: N-queen problem, Sum of subsets, Graph coloring. Branch and Bound: 15 Puzzle problem **Self-learning Topics:** Real life applications of all algorithms(https://www.geeksforgeeks.org/dsa/backtracking-algorithms/)	**7**	CO5
VI	**String Matching Algorithms**	The Naïve string-matching algorithm, The Rabin Karp algorithm, The Knuth-Morris-Pratt algorithm **Self-learning Topics:** Real life applications of all algorithms(https://www.geeksforgeeks.org/dsa/applications-of-string-matching-algorithms/)	**4**	CO6

Text Books:

1.T. H. Cormen, C.E. Leiserson, R. L. Rivest, and C. Stein, "Introduction to algorithms", 2nd Edition, PHI Publication 2005

2. Ellis Horowitz, Sartaj Sahni, S. Rajsekaran. "Fundamentals of computer algorithms" University Press.

Reference Books:

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

Online References:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/106/106/106106131/
2.	https://swayam.gov.in/nd1_noc19_cs47/preview
3.	https://www.coursera.org/specializations/algorithms
4.	https://www.mooc-list.com/tags/algorithms

Assessment:

- **Internal Assessment (IA) for 40 marks:**

  IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test.

End Semester Examination for 60 Marks:

Question paper format:

- Question Paper will comprise of a total of **six questions each carrying 15 marks Q.1** will be **compulsory** and should **cover 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 needs to be answered.**

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tuts	Theory	Practical	Tuts	Total
PEC6013	Deep 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					
PEC6013	Deep Learning	20	20	40	60	2	--	--	100

Pre requisite: -

Course Objectives: The course aims to

1. Introduce the fundamentals and building blocks of deep learning networks.
2. Explain optimization and regularization techniques to improve neural network performance.
3. Develop understanding of convolutional neural networks and recurrent neural networks and apply them to solve real-world problems.
4. Explain autoencoders and variational autoencoders for representation learning.
5. Familiarize students with GAN Networks and their applications.

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

1. Understand the fundamentals of deep learning and the terminologies in deep learning.
2. Apply regularization, optimization, parameter initialization, and batch normalization techniques to train deep neural networks effectively.
3. Analyze and design convolutional neural network architectures in different applications and compare their performance.
4. Understand recurrent neural networks and apply them in sequential data analysis.
5. Describe autoencoders and variational autoencoders and understand various applications of autoencoders
6. Understand recent deep learning architectures and algorithms and their uses in real world scenario.

Module No.	Topics	Hours	CO Mapping
1	**Introduction to Deep Learning** 1.1 Deep Learning Networks: Shallow versus deep neural networks, motivation for deep learning, and basic building blocks of deep learning models. 1.2 Deep Feedforward Networks and learning mechanism, Architecture of deep feedforward neural networks, forward propagation, and gradient-based learning. 1.3 Loss Functions: Role of loss functions in learning, Mean Absolute Error (MAE), Mean Squared Error (MSE), and Cross-Entropy loss. 1.4 Representation of Data for Deep Learning, Numerical representation of signals and images, vectors and matrices as data structures, concept of tensors, and representation of signals, images, and sequences as tensors. 1.5 Basics of Transfer Learning, Concept of transfer learning, use of pre-trained models, and significance in deep learning applications.	7	CO1
2	**Regularization and Optimization Techniques** 2.1 Regularization: Need of Regularization, L2 Regularization, L1 Regularization, Early Stopping and Dropout 2.2 Optimization: Challenges in NN Optimization, Gradient Descent Approaches, Adaptive Approaches - AdaGrad, RMSProp and Adam Optimizers 2.3 Parameter Initialization Methods 2.4 Introduction to Batch Normalization	6	CO2
3	**Convolution Neural Networks** 3.1 Basic CNN Architecture- Input Layer, Convolution layer, Pooling, Padding, Strided Convolution, Flattening, Fully Connected Layers and Output layer 3.2 Introduction of various CNN Architectures, LeNet, ResNet and UNet, Evaluation parameters 3.3 CNN in Image Classification and Object Detection	7	CO3
4	**Recurrent Networks** 4.1 Recurrent Neural Networks Bidirectional RNN, Encoder Decoder Architectures 4.2 Introduction to Long Short-Term Memory (LSTM) and GRU 4.3 Applications of RNN in Real World- Image Captioning, Time Series Forecasting and Prediction	5	CO4
5	**Autoencoders** 5.1 Autoencoder: Encoder-Decoder Model, Sparse ,Deep Autoencoder, Limitations of Autoencoders 5.2 Variational Autoencoders: Architecture, Reparameterization Trick, Latent Space Visualization	7	CO5

	5.3 Applications of Autoencoders and Variational Autoencoders- Image De-noising and Compression		
6	**Recent Trends and Applications** 6.1 Generative Adversarial Network (GAN), Generative Vs Discriminative Modelling, Architectural and training details of Generative Adversarial Networks, Loss Functions 6.2 Attention Mechanism-Architecture, Applications and limitations 6.3 Introduction to Transformers 6.4 Applications of GANs: Text-to-Image Translation, Image Augmentation	7	CO6
	Self Learning Topics *** Programming Frameworks: TensorFlow and PyTorch, Restricted Boltzman Machines, Keras API, Graph Neural Networks and applications, Large Language Models. ***No questions to be asked in Internal Assessments and End Semester Exam		

Text Books:

1. S. Sridhar, D. Narashiman ,Deep Learning , 1st Edition , Pearson
2. Ian Goodfellow, Yoshua Bengio & Aaron Courville,“Deep Learning”,MIT Press, 2016.
3. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer International Publishing, 2018

References:

1. Christopher Bishop, Pattern Recognition & Machine Learning, Springer-Verlag 2006.
2. Duda, Richard, Peter Hart, and David Stork, Pattern Classification, 2nd edition,Wiley-Interscience, 2000.
3. Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2015.
4. Pranati Rakshit, Deep Learning PHI Learning

Recommended Swayam NPTEL Courses:

1. NPTEL course on Deep learning by Prof. Sudarshan Iyengar, IIT Ropar.
2. NPTEL course on Deep learning by Prof. Prabir Kumar Biswas, IIT Kharagpur

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			Credits Assigned			
		Theory	Practical	Tuts	Theory	Practical	Tuts	Total
PEC6014	Internet of Things	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					
PEC6014	Internet of Things	20	20	40	60	2	-	-	100

Rationale:

This course aims to develop foundational understanding of principles, architectures, and enabling technologies of IoT systems relevant to Electrical, Electronics, and Telecommunication Engineering. It provides structured exposure to embedded platforms, communication protocols, data management, and security. The course strengthens analytical and design capabilities for modeling interconnected sensing and communication systems and applying engineering tools to develop scalable IoT solutions aligned with contemporary industry practices and societal needs.

Prerequisites:

1. 2303111-Mathematics for Signal Processing
2. 2304112-Microcontrollers
3. VSEC102 – C-Programming
4. 2303611- C++ and Java Programming

Course Objectives:

1. To introduce the fundamental concepts, architecture, and building blocks of Internet of Things (IoT) systems.
2. To develop understanding of sensing technologies, embedded platforms, and hardware–software integration used in IoT applications.
3. To familiarize learners with communication protocols, networking standards, and data exchange mechanisms relevant to IoT ecosystems.
4. To enable analysis of data management, cloud integration, and security considerations in interconnected systems.
5. To build capability in modeling and designing scalable IoT solutions using appropriate engineering tools and methodologies.
6. To prepare learners to address real-world engineering applications aligned with industry practices and emerging smart system developments

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

1. Explain IoT architecture, components, and workflows
2. Implement IoT communication using standard protocols

3. Design and interface sensors and actuators with IoT development platforms
4. Integrate IoT devices with cloud platforms
5. Evaluate security challenges, threats, and vulnerabilities in IoT systems and apply authentication, encryption, and security best practices
6. Design and implement a working IoT application

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Signals and Systems, Microprocessors and Microcontrollers, Basic understanding of Networking concepts and wireless communication, Basic programming knowledge in C/C++		
1	Fundamentals of Internet of Things and System Architecture	Fundamentals of Internet of Things: 1.1 Evolution, definition, and characteristics of Internet of Things 1.2 IoT ecosystem and enabling technologies. 1.3 IoT reference architectures and system workflows, 1.4 IoT vs M2M vs Cyber-Physical Systems, 1.5 IoT deployment levels and design considerations **Self-Learning Topics:** Investigate IoT levels (Level 1 through Level 6) and research actual products/deployments that correspond to each level. For each level, identify the typical hardware, connectivity, and cloud components involved, and analyse the cost vs capability trade-offs.	4	CO1
2	IoT Communication Protocols and Networking Technologies	Enabling Technologies and Protocols: 2.1 IoT communication models and layered network architecture, Wired and wireless communication technologies, Device IP addressing and identification, 2.2 Communication paradigms: Request–response and publish–subscribe models. 2.3 Application layer protocols: HTTP / REST, MQTT, CoAP. 2.4 Short-range communication technologies specification: Specifications and operating principles of short-range communication technologies including RFID, NFC, Bluetooth Low Energy (BLE), Wireless Sensor Networks (WSN), and an introduction to Zigbee and IEEE 802.15.4. 2.5 Internet and transport layer protocols for IoT connectivity: Overview of Internet protocols for IoT, IPv6 addressing and the need for IPv6 in IoT environments, concept of 6LoWPAN, and transport layer protocols with comparison of TCP and UDP. 2.6 Case study on IoT networking. **Self-Learning Topics:** Design a complete system workflow diagram for a smart irrigation system using a five-tier model — sensors, local processing, edge gateway, cloud, and application — documenting data flow and decision points at each tier.	8	CO2

3	IoT Hardware and Embedded Platforms	Sensors and Actuators: 3.1 IoT hardware building blocks, Microcontrollers vs System-on-Chip (SoC). 3.2 IoT development platforms: ESP32, Node MCU, Raspberry Pi, STM32 (overview). 3.3 Sensor/actuator selection, Interfacing, Data acquisition and control mechanisms, Power management and low-power IoT design. 3.4 Edge devices and IoT gateways. 3.5 Introduction to Python programming for IoT, GPIO and communication interfaces, 3.6 Case examples of simple IoT deployments, prototype development **Self-Learning Topics:** Compare development platforms systematically — ESP32 vs nRF52840 vs STM32L4 vs Raspberry Pi 4 — across dimensions of: processing power, memory, connectivity, power consumption (active and sleep), ecosystem maturity, and cost. Create a decision matrix for selecting the right platform for five different IoT scenarios.	8	CO3
4	IoT Data Management, Cloud Integration, and Analytics	Cloud computing: 4.1 Edge computing vs FOG vs cloud computing, Role in latency, scalability, bandwidth 4.2 IoT software stack and firmware lifecycle, Middleware and device management concepts 4.3 Cloud platforms for IoT: AWS IoT, Azure IoT (overview), Academic platforms (ThingSpeak, Blynk). 4.4 Data ingestion, storage, and processing, Real-time dashboards and visualization. 4.5 Introduction to IoT data analytics: Descriptive analytics, Basic pattern extraction, Decision support concepts **Self-Learning Topics:** Build a complete project using ThingSpeak/ Blynk for academic IoT: study ThingSpeak's MATLAB Analysis and React widgets for custom dashboards, and Blynk 2.0's virtual pins, automations, and webhook integration	7	CO4
5	IoT Security, Standards and Industrial Applications	Security and Threats: 5.1 Security challenges in IoT systems, Threats, vulnerabilities, and attack models, Authentication, authorization, and encryption. 5.2 IoT security best practices 5.3 IoT standards and frameworks: IEEE, IETF, oneM2M. 5.4 Compliance and interoperability considerations **Self-Learning Topics:** Study IoT regulatory and privacy frameworks: EU Cyber Resilience Act (CRA), UK PSTI Act, ENISA IoT Security Baseline, GDPR implications for IoT-collected personal data, and India's DPDP Act. Prepare a	7	CO5

		compliance checklist for a hypothetical wearable health IoT product targeting both EU and Indian markets.		
6	IoT Applications and Industrial Case Studies	IoT system design methodology (application level) Case studies: 6.1 Smart home and smart city applications, Healthcare applications, agriculture and environmental monitoring, Predictive maintenance and industrial monitoring, 6.2 Business models and value creation using IoT, 6.3 Emerging trends: AIoT, Digital twins. and Industry4.0 **Self-Learning Topics:** Study AIoT (AI + IoT) explore TinyML frameworks (TensorFlow Lite Micro, Edge Impulse, ONNX Runtime for edge),	5	CO6
			39	

Text Books:

1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press, 1st Edition, 2014.
2. S. Misra, A. Mukherjee, and A. Roy, 2020. Introduction to IoT. Cambridge University Press.
   Availability:https://www.amazon.in/Introduction-IoT-SudipMisra/dp/1108959741/ref=sr_1_1?dchild=1&keywords=sudip+misra&qid=1627359928&sr=8-1
3. Raj Kamal, "Internet of Things: Architecture and Design Principles", McGraw Hill Education, 1st Edition, 2017
4. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things: Key Applications and Protocols", Wiley, 2nd Edition, 2012.

Reference Books:

1. Adrian McEwen, Hakim Cassimally: Designing the Internet of Things", Paperback, First Edition.
2. Yashvant Kanetkar, Shrirang Korde : Paperback "21 Internet of Things (IOT) Experiments", BPB Publications

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 approx. 40% syllabus is completed and second class test (Internal Assessment II) when additional 35% syllabus is completed. The duration of each test shall be one hour.

End Semester Examination:

1. The question paper will comprise of a total 06 questions, each carrying 15 marks.
2. A total of 04 questions need to be solved.
3. Question No: 01 will be compulsory and should cover maximum content of the entire syllabus.
3. 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 (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
PEC6021	Embedded Systems	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					
PEC6021	Embedded Systems	20	20	40	60	2	--	--	100

Course Prerequisites:

1. 2304112-Microcontrollers
2. 2304411-Smart Embedded Systems with ATmega168/328

Course objectives:

1. Understand embedded processing platforms and design flow.
2. Explain embedded OS fundamentals and classification.
3. Analyse RTOS architecture, scheduling, and synchronization.
4. Study peripherals, protocols, and Edge AI technologies.
5. Learn reliability, safety, security, and certification standards.
6. Analyse industry case studies using design frameworks.

Course outcomes:

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

1. Compare processing platforms with design flow considerations.
2. Differentiate bare-metal, embedded OS, and RTOS designs.
3. Implement RTOS scheduling and task synchronization.
4. Interface peripherals and evaluate communication protocols and Edge AI solutions.
5. Apply reliability techniques and interpret safety standards.
6. Justify design decisions in industry case studies.

Module	Unit	Topics	Hrs
1		**Introduction to Embedded Systems and Processing Cores**	6
	1.1	**Embedded Systems Overview and Processor Architectures** - Definition, characteristics, block diagram, processor role - RISC and CISC architectures, ARM Cortex, RISC-V open ISA	
	1.2	**Processing Platforms and Multi-Core Architectures** - MCU, SoC, FPGA, CPLD, ASIC, ASIP: features and trade-offs - Heterogeneous multi-core SoCs combining real-time and application cores	
	1.3	**Core Selection Criteria and Specialized Cores** - Selection based on cost, power, performance, memory requirements - DSP, GPU, NPU and emerging trends in embedded processing	

	1.4	**Embedded System Design Flow** - Requirement analysis, hardware-software partitioning - Modelling, prototyping, testing and iteration	
		Self-Learning Topic: Real-world applications using different processing platforms and cores	
2		**Embedded Operating Systems**	5
	2.1	**Need and Fundamentals of Embedded OS** - Role in resource management, multitasking, timing predictability - Bare-metal vs OS-based design approaches - OS architecture, kernel functions, task states, - Cooperative and Preemptive Scheduling - Interrupt handling, IPC mechanisms (semaphores, queues), software timers - Basic memory management concepts	
	2.2	**Types of Embedded Operating Systems** - Off-the-shelf OS, embedded OS, RTOS comparison - Timing constraints, determinism, memory footprint, application domains	
		Self-Learning Topic: Applications using bare-metal, embedded OS, and RTOS	
3		**Real-Time Operating Systems (RTOS)**	8
	3.1	**Real-Time Concepts and RTOS Architecture** - Hard/soft real-time systems, deadlines, latency, jitter, determinism - RTOS kernel architecture, priority-based preemptive scheduling - Context switching, RMS and EDF scheduling (introductory)	
	3.2	**Task Management, IPC and Synchronization** - Task creation/deletion, task control blocks, task states - Semaphores, mutex, message queues, mailboxes, event flags - Priority inversion, deadlock concepts	
	3.3	**Interrupt Handling and Time Management** - RTOS ISRs, deferred interrupt processing, tick-based scheduling - Software timers	
		Self-Learning Topic: Open-source RTOS platforms (FreeRTOS, Zephyr, RTEMS) and applications	
4		**Peripherals, Communication and Edge AI**	6
	4.1	**Embedded Peripherals and Serial Protocols** - GPIO, ADC, DAC, Timers, PWM; sensors/actuators interfacing - UART, SPI, I²C: architecture, operation, comparison	
	4.2	**Industrial, Network and Wireless Communication** - CAN, USB, Ethernet, MODBUS, PROFIBUS, TCP/IP stack basics - Bluetooth, Wi-Fi, Zigbee, LoRa: range/power/data rate selection	
	4.3	**Edge AI and TinyML in Embedded Systems** - Edge AI vs Cloud AI concepts - TinyML workflow, AI-enabled microcontrollers, resource constraints	
		Self-Learning Topics: - Power-efficient Edge AI design techniques	

		- TinyML tools/frameworks (TensorFlow Lite Micro, uTensor) - Edge AI technology trends	
5		**Reliability, Safety and Certification**	7
	5.1	**Reliability Techniques and Security Fundamentals** - Basic reliability concepts, fault tolerance techniques - Brown-out detection (BOD), watchdog mechanisms - Redundancy methods and reliability measures - Embedded security fundamentals: Secure boot, firmware integrity - Common threats: Buffer overflow and side-channel attacks - Hardware security: TrustZone, secure elements	
	5.2	**Industry Safety Standards and Certification:** - ISO 26262 (Automotive systems) - IEC 61508 (Industrial safety systems) - DO-178C (Avionics software — overview) - Medical device compliance (introductory concept) - Basic concept of EMI/EMC compliance and product certification	
		Self-Learning Topic: - Advanced security: Cryptographic implementations, TLS/DTLS - MISRA C/C++ secure coding guidelines	
6		**Industry-Oriented Case Studies in Embedded Systems**	7
		Comparative Analysis Framework for Embedded Applications ***Applications:*** Water level monitoring, washing machine, PLC industrial automation, automotive ECU, smart band, smartphone ***Analysis criteria***: Core selection (MCU/SoC), design approach (bare-metal/RTOS), peripherals/protocols, Power/cost optimization, safety/certification requirements, industry trends	
		Self-Learning Topic: Detailed design analysis of one selected embedded system with complete trade-off evaluation	

Text Books

1. K. V. K. K. Prasad "Embedded/Real-Time Systems: Concepts, Design and Programming (Black Book) "*Dreamtech Press.*
2. Raj Kamal "Embedded Systems: Architecture, Programming and Design" *McGraw-Hill Education, 3rd Edition*
3. Jonathan W. Valvano "Embedded Systems: Introduction to ARM Cortex-M Microcontrollers" *Cengage Learning*
4. Frank Vahid, Tony Givargis "Embedded System Design: A Unified Hardware/Software Introduction" Wiley
5. David E. Simon "An Embedded Software Primer" Addison-Wesley

Reference Books

1. Joseph Yiu "The Definitive Guide to ARM Cortex-M3/M4" Elsevier/Newnes
2. Jean J. Labrosse "MicroC/OS-II: The Real-Time Kernel" CMP Books
3. K. C. Wang "Embedded and Real-Time Operating Systems" *Springer, 2nd Edition 2023.*
4. Shibu K. V. "Embedded Systems" McGraw-Hill Education

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
PEC6022	Robotics	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					
PEC6022	Robotics	20	20	40	60	2	--	--	100

Rationale:

The Robotics syllabus provides fundamental knowledge of robot structure and working principles. Kinematics and differential motion chapters help analyze robot movement and velocity. Trajectory and path planning ensure smooth and accurate robot operation. Robot vision enables robots to perceive and understand their surroundings using cameras and sensors for object detection and navigation. Task planning develops logical sequencing and control strategies. Service robots assist humans in tasks such as healthcare, domestic work, and delivery by performing operations autonomously. Overall, the syllabus prepares Electronics & Telecommunication students for automation and intelligent systems.

Prerequisite:

1. BSC201-Applied Mathematics II
2. 2303111-Mathematics for Signal Analysis
3. 2303114-Network Theory and Control System

Course Objectives:

1. To study basics of robotics
2. To familiarize students with the kinematics of robots.
3. To familiarize students with differential motion of robots
4. To familiarize students with Trajectory planning of robots.
5. To familiarize students with robot vision.
6. To familiarize students with Task planning of robots.

Course Outcomes:

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

1. Explain basic concept of robotics.
2. Describe the differential motion, add statics in robotics.
3. Describe the various path planning techniques.
4. Describe the dynamics and control in robotics industries.
5. Write program to use a robot for a typical application.
6. Use Robots in different applications.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	**Prerequisite**	Engineering mathematics (vectors, matrices, basic calculus), Control Systems Fundamentals	**-**	-
I	**Fundamentals of Robotics**	Robot Classification, Robot Components, Robot Specification, Joints, Coordinates, Coordinate frames, Workspace, Languages, Application **Self-learning Topics:** Introduction to Robotics – Academic Article https://catalogimages.wiley.com/images/db/pdf/9781119527626.excerpt.pdf	**5**	**CO1**
II	**Kinematics of Robots**	Homogeneous transformation matrices, Inverse transformation matrices, Forward and inverse kinematic equations – position and orientation. Denavit-Hatenberg representation of forward kinematics, Forward and inverse kinematic solutions of three and four axis robot **Self-learning Topics:** Robot Manipulator Control using Forward & Inverse Kinematics (Research Paper) https://arxiv.org/abs/2103.10461	**8**	**CO2**
III	**Velocity Kinematics & Dynamics**	Differential motions and Velocities: Differential relationship, Jacobian, Differential motion of a frame and robot, Inverse Jacobian, Singularities. Dynamic Analysis of Forces: Lagrangian mechanics, Newton Euler formulation, Dynamic equations of two axis robot **Self-learning Topics:** Geometric Jacobians and Singularity Analysis of Robot Manipulators https://arxiv.org/abs/1707.04821	**8**	**CO3**
IV	**Trajectory planning and Robot Vision**	Basics of Trajectory planning, Joint-Space trajectory planning, Cartesian-space trajectories, Image representation, Template matching, Polyhedral objects, Shape analysis, Segmentation, Iterative processing, Perspective transform, Camera Calibration **Self-learning Topics:** Image-Space Trajectory Planning for Robotic Machining (Case Study) https://www.sciencedirect.com/science/article/pii/S1755581723000056	**6**	**CO4**
V	**Task Planning & Service Robotics**	Task level programming, Uncertainty, Configuration Space, Gross motion Planning; Grasp planning, Fine-motion Planning, Simulation of Planer motion, Source and goal scenes, Task planner simulation.	**8**	**CO5**

		Need for service robots, Localization: Challenges of Localization, Map Representation, Probabilistic Map based Localization, Monte carlo localization, Landmark based navigation, Globally unique localization, Positioning beacon Systems, Route based localization, Planning and Navigation: Path planning overview, Cell decomposition path planning Potential field path planning-Obstacle avoidance **Self-learning Topics:** Path Planning of a Mobile Delivery Robot (Service Robot Case Study) https://pmc.ncbi.nlm.nih.gov/articles/PMC10648392/		
VI	**Applications**	Ariel robots, Collision avoidance, Robots for agriculture, mining, exploration, underwater, civilian and military applications, nuclear applications, Space applications, Humanoids **Self-learning Topics:** Agricultural Robots Case Study (Precision Farming) https://arxiv.org/abs/1911.03098	**4**	**CO6**

Textbooks:

1. Robert Shilling, "Fundamentals of Robotics - Analysis and control", Prentice Hall of India, 2009.
2. Saeed Benjamin Niku, "Introduction to Robotics–Analysis,Control, Applications", Wiley India Pvt. Ltd., Second Edition, 2011.
3. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2005.

Reference Books:

1. John J. Craig, "Introduction to Robotics – Mechanics & Control", Third Edition, Pearson Education, India, 2009
2. Mark W. Spong , Seth Hutchinson, M. Vidyasagar, "Robot Modeling & Control ", Wiley India Pvt. Ltd., 2006.
3. Mikell P. Groover et.al, "Industrial Robots-Technology, Programming & applications", McGraw Hill , New York, 2008.
4. Riadh Siaer, The future of Humanoid Robots- Research and applications, Intech Publications, 2012.

Online References:

Sr. No.	Website Name
1.	Swayam: Introduction to robotics https://onlinecourses.nptel.ac.in/noc20_de11/ preview
2.	MIT OpenCourseWare – Introduction to Robotics

	https://ocw.mit.edu/courses/2-12-introduction-to-robotics-fall-2005/
3.	Stanford Online – Robotics https://see.stanford.edu/Course/CS223A

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	Theory				Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg. of 2 Tests				
	Robotics Lab	--	--	--	--	**25**	**25**	**50**

Prerequisite: C/C++ Programming Language.	
Lab Objectives:	
1	To learn and understand the basics of fundamentals of robotics systems.
2	To be acquainted with different configuration of robotics system.
3	To design MATLAB program for robotic configuration.

Lab Outcomes: At the end of Laboratory work, the students will be able to	
1	Identify and understand the unique characteristics and components of robotics systems.
2	Compare and understand various types of robotics systems.
3	Design, simulate and test kinematic equations for robotic systems in MATALAB.
4	Compare and understand various industrial application of robotics systems.

Sr. No	Title of the Experiment	LO
1	Study of configuration of robots and motion of robot manipulator	LO1, LO2
2	Demonstration of various robotic configurations using industrial robot	LO1, LO2
3	Study of pick and place industrial robot	LO1, LO4
4	Study and analysis of robot grippers (includes the problems based on gripper force)	LO1
5	Work Envelope Calculation of 4 axis robotic arm	LO1, LO3
6	Implementation of Coordinate Transformation	LO3
7	Implementation of Homogeneous Coordinate Transformation	LO3
8	MATLAB program for simple kinematics of simple robot configuration	LO3
9	MATLAB program for inverse kinematics of simple robot configuration	LO3

10	Implementation of Trajectory Planning	LO3
11	To demonstrate simple robotic system using Matlab/ MscAdam/ RoboAnalyser software	LO3
12	Edge Detection for Automated Part Boundary Extraction in Robotic Quality Inspection Systems	LO4
13	Detect a Company Logo on Product Packaging in a Store Shelf Image Systems	LO4
14	Obstacle Avoidance Using Reinforcement Learning	LO2, LO4

Virtual Lab Links

1. Mechanisms & Robotics Lab http://vlabs.iitkgp.ernet.in/mr/
2. Robotics Application Lab https://vlab.amrita.edu/?sub=3&brch=271&sim=1642&cnt=3525
3. Bio Inspired Robotics Virtual Lab https://vlab.amrita.edu/?sub=3&brch=257

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practical's 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
PEC6023	Web Design	3	--	-	3	-	-	3

Course Code	Course Name	Theory							
		Internal Assessment (IAT)			End Sem Exam	Exam Duration (in Hrs)	Term work	Pract/ Oral	Total
		IAT-I	IAT- II	Total					
PEC6023	Web Design	20	20	40	60	2	--	--	100

Rationale:

Web Design focuses on designing and developing websites using modern web technologies. It provides the fundamental knowledge required to create structured, interactive, and user-friendly web pages using tools like **HTML**, **CSS**, and **JavaScript**.

Prerequisite:

1. VSEC102 : C Programming
2. 2303611: C++ & Java Programming

Course Objectives:

1. To understand the fundamentals of the Internet, web protocols, the World Wide Web, and version control using Git and GitHub.
2. To learn the principles of web design using HTML5, CSS3, and Bootstrap for creating structured and visually appealing web pages.
3. To develop interactive and dynamic web applications using JavaScript, DOM manipulation, and AJAX.
4. To understand server-side programming using PHP for handling web requests, session management, and database connectivity with MySQL.
5. To explore XML technologies for structured data representation and processing.
6. To introduce modern front-end development concepts using ReactJS and component-based architecture.

Course Outcomes:

On successful completion of the students will be able to:

1. Apply internet protocols, HTTP communication, and version control using Git and GitHub for collaborative web development.
2. Design structured, visually appealing, and responsive web pages using HTML5, CSS3, and Bootstrap.
3. Develop an interactive web application using JavaScript, DOM manipulation, AJAX, and jQuery.
4. Implement server-side scripting using PHP and MySQL for database-driven applications.
5. Apply XML technologies for structured data representation and exchange
6. Develop component-based web applications using ReactJS.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to the Internet & Web Technologies**	**1.1 Internet Fundamentals, Web Architecture and Protocols:** 3 Tier Web architecture, HTTP request and response messages, web clients and web servers. **1.2 HTML:** Introduction, history, versions and basic elements. HTML5 elements: headings, paragraphs, links, lists, tables, images, forms. **1.3 Git & GitHub:** Introduction, pushing source code, pull requests and collaboration.	**02** **03** **01**	**CO1**
	Self-learning topic	**HTML Multimedia and HTML5 Semantic Elements:** Audio, Video, Canvas, iframe, semantic tags. **GitHub Workflow and Branching Concept:** Creating branches, merging, resolving simple conflicts.		
II	**Styling with CSS3 & Bootstrap**	**2.1 CSS Fundamentals:** Concept of CSS, types of style sheets, selectors, ID and class. Colors, fonts, backgrounds and text formatting. **2.2 Layout and Styling:** Box model (margin, padding, border), display property, dimensions, positioning and floating. Pseudo-classes and simple navigation bar design. **2.3 Bootstrap Framework:** Introduction to Bootstrap, grid system, basic components and responsive web design.	**02** **02** **02**	**CO2**
	Self-learning topic	CSS Flex box and CSS Grid Layout.		

III	**JavaScript AJAX**	**3.1 JavaScript Fundamentals:** Introduction, syntax, variables, data types, operators, functions, arrays and objects. Event handling and basic debugging. **3.2 Document Object Model (DOM):** Selecting elements, modifying content and styles, and document tree manipulation. **3.3 jQuery and AJAX:** Introduction to jQuery, selectors and event handling. Introduction to AJAX, working with JSON, API integration and form handling using AJAX.	**03** **02** **03**	**CO3**
	Self-learning topic	Asynchronous JavaScript, JSON JS graphics : Plotly.js, Chart.js, Google Chart		
IV	**Server-Side Programming with PHP &My SQL**	**4.1 PHP Fundamentals:** Introduction to PHP, syntax, variables, data types, operators and expressions. Control statements, arrays and functions. **4.2 Form Handling & MVC Concept:** Handling form data using GET and POST methods. Introduction to MVC architecture & its role in web application development, cookies and session tracking. **4.3 Database Connectivity:** Introduction to MySQL database. Connecting PHP with MySQL for basic database operations (insert, update, delete, select).	**03** **02** **02**	**CO4**
	Self-learning topic	Creating a MySQL database and performing basic CRUD operations using MySQL.		
V	**XML &Data Exchange Technologies**	**5.1 XML Fundamentals:** Introduction to XML, structure of XML document, elements and attributes. Document Type Definition (DTD) and XML Schema (basic concept). **5.2 XML Processing:** Introduction to DOM and SAX parsers (conceptual overview). **5.3 XML Presentation and Data Exchange:** Introduction to XSLT and role of XML in data exchange applications.	**02** **02** **02**	**CO5**
	Self-learning topic	XML usage in web services and server-side applications.		

VI	**Introduction to Modern Frontend Development using React JS**	**6.1 React Basics:** Overview of React, need for React in modern web development, introduction to JSX and components. **6.2 Components and Props:** Creating simple functional components and passing data using props. **6.3 Basic State and API Concept:** Introduction to state using use State hook. Basic idea of API integration and single-page applications.	**02** **02** **02**	**CO6**
	Self-learning topic	Comparison of modern frontend frameworks: React, Angular and Vue (overview).		

Text Books:

1. Kogent Learning Solutions Inc., *Web Technologies: HTML, JavaScript, PHP, Java, JSP, XML and AJAX, Black Book*. Dreamtech Press, 2012.
2. L. Lemay, R. Colburn, and J. Kyrnin, *HTML, CSS & JavaScript Web Publishing*, Pearson Education, 2015.
3. B. McLaughlin, *PHP &MySQL: The Missing Manual. O'Reilly Media, 2018*.
4. D. Flanagan, *JavaScript: The Definitive Guide*, 7th ed. O'Reilly Media, 2020.
5. Stefano, *React Up and Running: Building Web Applications*. O'Reilly Media, 2016.

References:

1. R. York, *Beginning JavaScript and CSS Development with jQuery*. Wrox Publications, 2009.
2. R. Nixon, *Learning PHP, MySQL & JavaScript*, 5thed. O'Reilly Media, 2021.
3. T. A. Powell, *AJAX: The Complete Reference*. McGraw-Hill Education, 2008.
4. B. Evjen, *Professional XML*, Wrox Publications, 2007.
5. Boduch, React and React Native. Packt Publishing, 2020.

Online References:

Sr. No.	Website Name
1	Mozilla Developer Network(MDN),"MDN Web Docs," https://developer.mozilla.org/
2	ReactJS,"React Documentation,"https://react.dev/.
3	PHP.net,"PHP Manual,"https://www.php.net/manual/en/
4	Bootstrap,"Bootstrap Documentation,"https://getbootstrap.com/
5	GitHub LearningLab,"Learn Git and GitHub,"https://lab.github.com/

List of Self Learning Topics

Module 1	**HTML Multimedia and HTML5 Semantic Elements:** Audio, Video, Canvas, iframe, semantic tags. **GitHub Workflow and Branching Concept** Creating branches, merging, resolving simple conflicts.	https://www.youtube.com/watch?v=D1-tUcY7uqM https://www.youtube.com/watch?v=DBaZPyXNgpA https://www.youtube.com/watch?v=gW6dFpTMk8s
Module 2	CSS Flexbox & CSS Grid Layout	https://www.youtube.com/watch?v=DJq6R2b0FoE
Module 3	Asynchronous JavaScript, JSON JS graphics : Plotly.js, Chart.js, Google Chart	https://www.w3schools.com/js/js_graphics_chartjs
Module 4	Creating a MySQL database and performing basic CRUD operations using MySQLi.	https://www.youtube.com/playlist?list=PLyqSpQzTE6M-xymXgqewlzcC3U4cdRoSu
Module 5	XML usage in web services and server-side applications.	https://www.w3schools.com/xml/ajax_intro.asp
Module 6	Comparison of modern frontend frameworks:React, Angular & Vue(Overview)	https://www.youtube.com/watch?v=FruCVzHTzXE&t=3s

Internal 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**

a. 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**

b. **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)

c. A total of **four questions** need to be answer.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
PEC6024	Network Management in Telecommunication	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					
PEC6024	Network Management in Telecommunication	20	20	40	60	2	--	--	100

Rationale:

Telecommunication networks are complex systems that require efficient management to ensure reliability, performance, and security. This course introduces fundamental concepts, standards, and protocols of network management such as OSI network management, SNMP, TMN, and FCAPS. It enables learners to monitor, control, and optimize network operations effectively. The course prepares students for roles in network administration and telecommunication service management.

Prerequisite: -

Course Objectives:

1. To provide a basic understanding of telecommunication network design principles and network management concepts.
2. To introduce the OSI Network Management model, including its layers, functions, and management protocols.
3. To provide an understanding of Internet network management using SNMP, including its models, versions (SNMPv1, SNMPv2, and SNMPv3), security mechanisms, and remote network monitoring concepts.
4. To provide a clear understanding of Telecommunication Management Networks (TMN), including their framework, models, and management services.
5. To provide knowledge of network management systems, tools, and applications for effective monitoring and control of networks.
6. To understand broadband networks, ATM technology, and ATM network management principles.

Course Outcomes:

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

1. Explain fundamental concepts of telecommunication network management, including network management goals, architectures, and standards.

2. Describe the OSI network management architecture, including organizational, information, communication, and functional models.

3. Explain Internet network management using SNMP by detailing its architecture, operations, versions (SNMPv1, SNMPv2, and SNMPv3), security mechanisms, and RMON concepts.

4. Describe Telecommunication Management Network (TMN) architecture, including its functional and conceptual models and service management concepts.

5. Analyze network management systems by applying FCAPS functions and key techniques for monitoring, reporting, event correlation, and policy-based management.

6. Apply concepts of broadband and ATM network management, including ATM architecture, management models, and standard management interfaces (M1–M4), to analyze telecommunication network operations.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	**Prerequisite**		-	-
I	Introduction to Telecommunication Network Management	1.1 Introduction to Network Management; Case Histories on Network Management; System and Service Management; Challenges of an IT Manager; Need for NMS; Goal of Network Management. 1.2 Network Management architecture and Organization; Network Management perspectives; Network Management Standards. **Self-learning Topic:** Best practices for designing scalable and resilient enterprise networks; introduction to the role of automation and AI-assisted approaches in modern network management (conceptual overview).	**6**	**CO1**
II	OSI Network Management	2.1 OSI Network Management Model. 2.2 OSI Organizational Model, Information Model 2.3 OSI Communication Model and Functional Model.	**8**	**CO2**

		2.5 OSI Management protocol and services (CMIP, CMISE) 2.6 Introduction to ASN.1and BER (TLV format). **Self-learning Topic:** Importance of OSI-based network management standards in providing structured, interoperable, and vendor-independent network management frameworks.		
III	Internet Management	3.1 Introduction to Internet Management: Simple Network Management Protocol (SNMP); Structure of Management Information (SMI); Management Information Base (MIB); SNMP message encoding using ASN.1 and BER (TLV format). 3.2 SNMP v1: SNMP v1 architecture; SNMP Communication Model; Administrative model; SNMP Protocol Specifications and Operations. 3.3 SNMPv2: Major changes in SNMPv2; SNMPv2 Architecture; SNMPv2 management information base; SNMPv2 protocol; Compatibility with SNMPv1. 3.4 SNMPv3: Key Features and SNMPv3 architecture, SNMPv3 message format, SNMPv3 security; User-based Security Model, Access control (VACM); SNMPv3 applications 3.5 Remote Monitoring: Introduction to RMON, and comparison of RMON 1 and RMON 2. **Self-learning Topic:** Evolution of Internet-based network management from SNMPv1 to SNMPv3 and RMON, with emphasis on scalability, security, and monitoring capabilities.	**10**	**CO3**
IV	Telecommunication Management Networks (TMN)	4.1 Definition and need for Telecommunication Management Network (TMN); TMN framework; TMN functional model. 4.2 TMN conceptual model; mapping of OSI network management functionality within TMN. 4.3 TMN management services architecture; TMN implementation concepts; overview of eTOM as a	**04**	**CO4**

		business process framework for telecom service management. **Self-learning Topic:** Role of TMN and related service management frameworks in achieving service assurance and operational efficiency in telecommunication networks.		
V	Network Management Tools and Applications	5.1 Network Management System (NMS): Functional requirements; NMS client–server architecture; centralized and distributed management approaches. 5.2 Network Operations Center (NOC): Role and functions of a NOC; basic NOC architecture and workflow; fault detection, alarms, escalation; key performance indicators (KPIs). 5.3 FCAPS Management: Application of fault, configuration, accounting, performance, and security management in practical network environments; proactive vs reactive management. 5.4 Introduction to AI in Network Management (conceptual): Need for AI-assisted management; anomaly detection and predictive performance/fault management; overview of automated and self-healing networks. 5.5 Event correlation and automation: Rule-based and AI-assisted correlation; threshold-based and anomaly-based alerting concepts. 5.6 Emerging web-based management technologies (conceptual overview): Web-Based Enterprise Management (WBEM), Java Management Extensions (JMX), XML-based and CORBA-based network management; comparison with SNMP-based management. **Self-learning Topic**: Role of automation and AI-assisted approaches in improving network monitoring and service assurance.	**07**	**CO5**
VI	Broadband Network Management	6.1 Broadband networks and services; ATM technology – virtual path (VP), virtual channel	**4**	**CO6**

		(VC), ATM cells/packets, integrated services, ATM LAN emulation. 6.2 ATM network management – ATM network reference model; integrated local management interface. 6.3 ATM management information base (MIB); management interfaces M1, M2, M3, and M4. **Self-learning Topic:** Role of broadband and ATM-based infrastructures in supporting integrated multimedia network services.		

Textbooks:

1. Mani Subramaniam, *Network Management: Principles and Practice*, 2nd Edition, Pearson Education, New Delhi.
2. Alexander Clemm, *Network Management Fundamentals*, Cisco Press, 2006, ISBN-13: 978-1587201370.

Reference Books:

1. Behrouz A. Forouzan, *Data Communications and Networking*, 5th Edition, McGraw-Hill Education.
2. Andrew S. Tanenbaum, David J. Wetherall, *Computer Networks*, 5th Edition, Pearson Education
3. Benoit Claise, Ralf Wolter, *Network Management: Accounting and Performance Strategies*, Cisco Press.
4. J. Richard Burke, *Network Management: Concepts and Practice – A Hands-On Approach*, Pearson Education.
5. Thomas D. Nadeau, Ken Gray, *SDN: Software Defined Networks*, O'Reilly Media.
6. David Medhi, Karthik Ramasamy, *Network Routing: Algorithms, Protocols, and Architectures*, 2nd Edition, Morgan Kaufmann.
7. A. D. Green, *Network Management: Principles and Practice*, Addison-Wesley, 1993.

Online reference:

1. **https://www.ibm.com/think/topics/network-operations-center**
2. **https://www.techtarget.com/searchnetworking/definition/network-operations-center**

Assessment:

Internal Assessment (IA) Test:

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

syllabus is completed. The duration of each test shall be one hour.

End-of-Semester Examination:

1. The question paper shall comprise a total of six (06) questions, each carrying 15 marks.

2. Four (04) questions are to be solved.

3. Question No. 1 shall be compulsory and shall cover the maximum content from the entire syllabus.

4. The remaining questions shall be selected from all the modules based on the weightage of each module, which shall be proportional to the number of lecture hours specified in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
PCL601	Image Processing and Machine Vision 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				
PCL601	Image Processing and Machine Vision Laboratory	--	--	--	--	25	25	50

Prerequisites:

1. VSEC202-Python Programming

Laboratory Objectives:

1. To teach implementing basic theoretical concepts in Image Processing and Machine Vision using relevant software.
2. To give an exposure to students to object recognition/ classification techniques in Machine Vision.
3. To facilitate students for understanding practical aspects of Image Processing and Machine Vision through an application.

Laboratory Outcomes:

After successful completion of the course student will be able to

1. Perform enhancement of digital images in spatial and frequency domain.
2. Perform edge detection and morphological operations on digital images.
3. Classify patterns using standard Machine vision classification techniques like SVM.
4. Apply theoretical knowledge in image processing and machine vision to practical case studies.

Suggested List of Experiments:

1. Eight experiments covering the whole syllabus with proportional weightage to Image Processing and Machine Vision, to be set with predefined and concrete objective problem statement.
2. At least 5 programs to be conducted in python programming
3. At least 1 case study from suggested ones to be conducted in lab.

4. An attempt should be made to make experiments more meaningful, interesting and innovative.
5. Conduct three experiment based on application of **Neural Network and Fuzzy logic** for Image Processing.

Sr. No.	NAME OF EXPERIMENTS
1.	Point Processing Methods - Negative, Log, Power law, Contrast stretching, Bit plane slicing
2.	Histogram calculation and equalization
3.	Spatial Domain Filtering: • Smoothening filters • Sharpening with Laplacian • Unsharp masking & high boost filtering • Edge detection using 1st and 2nd order derivatives
4.	Frequency Domain Filtering : Ideal, Butterworth and Gaussian
5.	Morphological operation – Erosion, dilation, opening, closing, hit-miss transform, Boundary extraction
6.	Image segmentation using global Thresholding Algorithm
7.	Shape representation using chain code
8.	Canny edge detection
9.	Feature extraction using co-occurrence matrix
10.	Classification using k-means algorithm
11.	Classification using Basiyan classifier
12.	Basic binary classification of any data or pattern using Support Vector Machine.
13.	Case Study: • Face recognition • Finger print identification • License plate recognition

Text/Reference Books:

1. R. C. Gonzalez and R. E. Woods, *Digital Image Processing*, 4th ed. Noida, India: Pearson Education, 2018.
2. M. Sonka, V. Hlavac, and R. Boyle, *Image Processing, Analysis, and Machine Vision*, 4th ed. Boston, MA, USA: Cengage Learning, 2014.
3. R. Jain, R. Kasturi, and B. G. Schunck, *Machine Vision*. New York, NY, USA: McGraw-Hill, 1995.
4. B. A. Maxwell, "Comparative Review of Image Processing and Computer Vision Textbooks," in *Proc. SPIE*, vol. 1607, pp. 1–12, 2003.

Assessment:

Term Work: Term Work shall consist of evaluation of experiments (12 Marks), programs (5 Marks), and case-study (3 Marks) as described above. Five Marks shall be for the 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	Practical	Tutorial	Theory	Practical	Tutorial	Total
PCL602	Digital VLSI Lab	–	02	–	–	01	–	01

Course Code	Course Name	Examination Scheme				Term-work	Pract /Oral	Total
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Total				
PCL602	Digital VLSI Lab	–	–	–	–	25	25	50

Pre-requisite:

- 2303112-Electronic Devices and Linear Circuits
- 2303113-Digital System Design

Laboratory Course Objectives:

1. To understand and get familiarized with open-source VLSI design tools (e.g., Ngspice, Magic) for circuit simulation and layout design.
2. To perform various types of analysis of combinational and sequential circuits using CMOS and other design styles.
3. To evaluate performance parameters of given combinational and sequential CMOS circuits.
4. To design CMOS circuits and verify their functionality using simulation and layout tools
5. To understand RTL and HDL concepts to model digital circuits and realize them on FPGA platforms.

Laboratory Course Outcomes

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

1. To install the open source VLSI design tools and use it for circuit simulation and layout design.
2. To design and implement given combinational and sequential circuits for given specifications.
3. To analyze different simulations (DC, transient, operating point) for CMOS circuits.
4. To draw and analyze layout of a given CMOS circuit using layout tool.
5. To implement and validate digital circuits using HDL on FPGA platforms.

Suggested list of experiments: (Course teacher can design their own experiments based on the prescribed syllabus)

1. Constant Voltage and Constant field MOSFET scaling.
2. Voltage transfer characteristics of CMOS inverter and calculation of Noise Margin and static power.
3. Transient Analysis of CMOS inverter and calculation of tpHL, tpLH, tr, tf, average power
4. Comparative analysis of different types of Inverter (resistive load, NMOS load, PMOS load, CMOS)
5. Design layout of CMOS inverter
6. Design layout of 2 input CMOS NAND/NOR gate
7. Static and transient analysis of Complex CMOS gate.
8. Implementation of various combinational circuits using different design styles.
9. Implementation of various sequential circuits using different design styles.
10. Design and implementation of NAND based and NOR based ROM arrays.
11. Performance analysis of 6T-SRAM Cell
12. Performance analysis of 1T and 3T DRAM Cell
13. Comparative analysis of Fast adders/ multipliers
14. RTL design of Soda dispenser machine
15. Implementation of combinational circuits using HDL on FPGA board
16. Implementation of sequential circuits using HDL on FPGA board

Link for virtual lab

- http://www.vlsi-iitg.vlabs.ac.in

Term Work:-

- Term Work shall consist of at least 8-10 experiments (at least three experiments on layout) covering the entire syllabus and must be given "Batch Wise".
- The experiments can be conducted with the help of simulation tools.
- The teacher should refer to the suggested list of experiments and can design additional experiments to acquire practical design skills.
- The experiments should be student centric and attempts 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 and assignments graded from time to time.
- Term work Journal must include at least 2 assignments.
- Assignment can be in form of mini project using FPGA board
- Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 05 Marks (Assignments) + 05 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
PEL6011	Database Management Systems 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	Total				
PEL6011	Database Management Systems Lab	--	--	--	--	25	25	50

Prerequisite: -

Course Objectives:

1. Understand the **concepts of database systems, data models, and schema design**.
2. Develop the ability to **design ER and EER models** and perform **ER-to-relational mapping**.
3. Implement and manage **relational databases** using **SQL commands** (DDL, DML, DCL, and TCL).
4. Apply **integrity constraints, keys, and relational operations** for maintaining data accuracy.
5. Develop proficiency in **PL/SQL programming** including procedures, functions, triggers, and views.
6. Demonstrate **transaction management, NoSQL operations**, and **front-end/back-end database connectivity** through a mini project.

Course Outcomes:

After successful completion of the course student will be able to

	Laboratory Outcome
LO1	Design and represent data using ER and EER models and convert them into relational schemas.
LO2	Create, modify, and manipulate relational databases using SQL commands.
LO3	Apply keys, constraints, and integrity rules to maintain data accuracy and consistency.
LO4	Write, test, and execute SQL and PL/SQL programs including functions, procedures, triggers, and views.
LO5	Demonstrate transaction management, concurrency control, and recovery mechanisms using SQL.
LO6	Perform CRUD operations using NoSQL databases and integrate database with front-end applications.

The below suggested experiments needs to be performed by a group of **2 students. (Mini 10 Experiments)**

- **Suggestion:** Select any database management system problem statement and try to execute all experiments based on the same topic

List of Experiments:

Week No	List of Experiments	Hrs	LO
	Compulsory		
01	Relational Model and Keys and Integrity Constraints Implementation	02	2,3
02	ER Model Design and ER to Relational Mapping and EER Model Design	02	1
03	Implement DDL(CREATE, ALTER, DROP, TRUNCATE tables) and apply constraints(PRIMARY KEY, FOREIGN KEY, UNIQUE, CHECK, NOT NULL)	02	2,3
04	Implement DML Commands(INSERT, UPDATE, DELETE, SELECT queries.)	02	2
	Any one		
05	Implement Simple queries using Math, Date and String functions	02	2,4
06	Implement Simple queries, using aggregate functions and Grouping(Group by , having etc clauses).	02	2,4
	Any One		
07	implement PL/SQL Basics(conditional Statement) , Stored Procedures & Functions	02	4
08	implement PL/SQL Basics(Loop statement) , Stored Procedures & Functions	02	4
	Any One		
09	Implement Views and Operations on Views	02	4
10	Implement Trigger(BEFORE and AFTER for INSERT/UPDATE/DELETE)	02	4
	Any One		
11	Implement Joins (Cartesian product ,Inner(Equi, Theta and Natural) and Outter(Rigth, Left, Full outter)	02	4
12	Implementation and demonstration of Transaction(COMMIT, ROLLBACK, SAVEPOINT) and Concurrency control techniques using locks.	02	5
	Compulsory		
13	Perform CRUD Operations in NoSQL(Insert, Read, Update, Delete operations)	02	6
14	Mini project (Design simple GUI and Backend Connectivity)	02	6
Note	For Mini Project students can use AI tool to design front, Normalized table, Integration with back end. Along with Project Students are expected to submit prompt used for projects		

List of Assignments: Any Two

Sr. No	List of Assignment/Tutorial	Hrs
01	List of Assignments Based on Latest Trends in DBMS	01
02	Big Data and Distributed Databases	01
03	Database Security and Privacy	01
04	Integration of AI and Machine Learning with Databases	01
05	Blockchain and Decentralized Databases	

AI & Online Tools	
Database & SQL Tools	
	1. **DB-Fiddle** – https://db-fiddle.com o Online SQL execution (MySQL, PostgreSQL).
	2. **SQLite Online** – https://sqliteonline.com o Lightweight DBMS for practice.
	3. **phpMyAdmin (XAMPP)** – Free local MySQL practice.
	4. **Oracle Live SQL** – https://livesql.oracle.com o Free Oracle SQL & PL/SQL environment
ER Diagram & Design Tools	
	5. **Draw.io (diagrams.net)** o ER, EER, schema diagrams.
	6. **ERDPlus** – https://erdplus.com o ER to relational mapping tool.
NoSQL Tools	
	7. **MongoDB Atlas (Free Tier)** o Cloud-based NoSQL practice.
	8. **MongoDB Compass (Free GUI)**
	9. **Firebase Console (Free tier)**
AI Tools for Learning & Assistance	
	10. **ChatGPT (Free version)** o SQL queries, normalization, PL/SQL logic.
	11. **Perplexity AI (Free)** o Concept clarification and examples.
	12. **GitHub Copilot (Student Free via GitHub Education)**
	13. **Khan Academy SQL** o Beginner-friendly SQL practice

Assessment:

Term Work: Term Work shall consist of at least 09, Mini Project ie total 10 experiments and Any two assignment on topic as suggested in the above list.

Term Work Marks: 25 Marks (Total marks)
15 Marks (Performance/Submission + Results/Clarity+Assignments)
5 Mark (Evaluation – Quiz , MCQ Test , Viva etc)
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
PEL6012	Analysis of Algorithm 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	Total				
PEL6012	Analysis of Algorithm Lab	--	--	--	--	25	25	50

Prerequisite:

1. VSEC102-C Programming

Course Objectives:

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

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

1. Implement the algorithms using different problem solving approaches.
2. Analyze the complexities of various algorithms.
3. Compare the complexity of the different algorithms for specific problem.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Basic knowledge of C programming		
I	Introduction	Performance analysis, space, and time complexity Growth of function, Big- Oh, Omega, Theta Notation Mathematical background for algorithm analysis. Analysis of selection sort, insertion sort. Recurrences: The substitution method, Master method **Self-learning Topics:** Recursion tree method, Complexity class: Definition of P, NP, NP-Hard, NP-Complete	2	**LO1, LO2, LO3**
II	Divide and Conquer Approach	General method, Merge sort, Quick sort, Analysis of Linear Search and Binary search **Self-learning Topics:** Finding minimum and maximum algorithms and their Analysis, Strassen's Algorithm, real life applications of all algorithms	2	**LO1, LO2, LO3**

III	Greedy Method Approach	General Method, Single source shortest path: Dijkstra Algorithm, Fractional Knapsack problem, Minimum cost spanning trees: Kruskal and Prim's algorithms **Self-learning Topics:** Job sequencing with deadlines, real life applications of all algorithms	2	**LO1, LO2, LO3**
IV	Dynamic Programming Approach	General Method, Multistage graphs, All pair shortest path: Floyd Warshall Algorithm, 0/1 knapsack Problem, Travelling Salesperson problem, Longest common subsequence. **Self-learning Topics:** Bellman Ford Algorithm, real life applications of all algorithms	2	**LO1, LO2, LO3**
V	Backtracking and Branch and bound	General Method, Backtracking: N-queen problem, Sum of subsets, Graph coloring. Branch and Bound: 15 Puzzle problem **Self-learning Topics:** Real life applications of all algorithms	2	**LO1, LO2, LO3**
VI	String Matching Algorithms	The Naïve string-matching algorithm, The Rabin Karp algorithm, The Knuth-Morris-Pratt algorithm **Self-learning Topics:** Real life applications of all algorithms	2	**LO1, LO2, LO3**

Text Books:

1. T. H. Cormen, C.E. Leiserson, R. L. Rivest, and C. Stein, "Introduction to algorithms", 2nd Edition, PHI Publication 2005.
2. Ellis Horowitz, Sartaj Sahni, S. Rajsekaran. "Fundamentals of computer algorithms" University Press.

Reference Books:

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

Online Resources:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/106/106/106106131/
2.	https://swayam.gov.in/nd1_noc19_cs47/preview
3.	https://www.coursera.org/specializations/algorithms
4.	https://www.mooc-list.com/tags/algorithms

Sr No	List of Assignments / Tutorials	Hrs
01	Assignment covers the topics from first three units limited to three Questions per unit	2
02	Assignment covers the topics from Last three units limited to three Questions per unit	2

Suggested list of Experiments.

Sr No	Title of Experiments	Hrs
01	Experiment based on common mathematical functions.(Selection sort, Insertion sort)	2
02	Experiment based on divide and conquers approach. (Merge sort, Quick sort, linear search, Binary Search)	2
03	Experiment based on greedy approach. (Single source shortest path- Dijkstra Fractional Knapsack problem, Minimum cost spanning trees-Kruskal and Prim's algorithm)	2
04	Experiment using dynamic programming approach (All pair shortest path- Floyd Warshall, 0/1 knapsack)	2
05	Travelling salesperson problem, Longest common subsequence using dynamic programming approach	2
06	Experiment using Backtracking strategy. (N-queen problem, Sum of subsets, Graph coloring)	2
07	Experiment using branch and bound strategy. (15 puzzle)	2
08	Experiment based on string matching/amortized analysis (The Naïve string-matching Algorithms ,The Rabin Karp algorithm, The Knuth-Morris-Pratt algorithm.	2
09	Implementation Min-Max Algorithm	2
10	Implementation of Job Sequencing with deadlines.	2
11	Implementation of Bellman Ford Algorithm using Dynamic programming	2

Assessment:

Term Work: Term Work shall consist of at least 08 to 10 practical's 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
PEL6013	Deep 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				
PEL6013	Deep Learning Laboratory	--	--	--	--	25	25	50

Prerequisite:

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

Course Objectives:

1. To understand the working of feed forward networks.
2. To implement various Regularization and Optimization techniques for feedforward neural networks.
3. To design deep learning models for supervised, unsupervised and sequence learning.
4. To understand the working of Auto encoders and GAN networks

Course Outcomes:

After successful completion of the course student will be able to

1. Design feed forward networks using back propagation algorithm.
2. Select and train CNN Models for real time applications.
3. Improve the performance of Deep Neural Networks using Regularization and Optimization techniques.
4. Implement the RNN Networks for sequential data analysis.
5. Design autoencoders and variational autoencoders as per the application.
6. Explain recent deep learning architectures and algorithms in Generative AI.

Suggested List of Experiments:

No	List of Experiments	LO
1	Build a Deep Feed Forward ANN by implementing the Backpropagation algorithm and test the same using appropriate data sets. Use the number of hidden layers >=2.	1
2	Design and implement a CNN model (with minimum 2 layers of convolutions) to classify multi category image datasets. Record the accuracy corresponding to the number of epochs.	2
3	Perform transfer learning by fine-tuning a ResNet-18 model trained on the ImageNet1k dataset, to classify images	2

4	Implement object detection using UNet	2
5	Implement the standard LeNet-5 CNN architecture model to classify multi - category image dataset. Use the concept of regularization and dropout while designing the model. Record the Training accuracy and Test accuracy corresponding to the following architectures: a. Base Model b. Model with L1 Regularization c. Model with L2 Regularization d. Model with Dropout e. Model with both L2 (or L1) and Dropout	3
6	Design Standard CNN Architecture and test the accuracy using adaptive optimizers	3
7	Implement RNN for sentiment analysis on social media	4
8	Implement LSTM for Time Series Prediction	4
9	Write a program to predict a caption for a sample image using LSTM	4
10	Implement Auto encoders for image denoising on any suitable dataset.	5
11	Perform Image Compression using autoencoders	5
12	Perform Image Augmentation using Generative Adversarial Network	6
13	Implement Generative Adversarial Networks to generate realistic Images.	6
14	Perform Network optimization to monitor, manage and improve network performance and reliability using suitable deep learning architecture	6
15	Design Deep learning models, to analyse images of electronic components to find microscopic defects handling variations in lighting conditions	6

Suggested List of Assignments:

Sr. No	List of Assignment/Tutorial	LO
01	Predictive Maintenance using Deep learning	6
02	Deep leaning for health care applications	6
03	Industrial Automation using AI	6
04	Role of Deep Learning in Semiconductor Industry	6

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
PEL6014	Internet of Things Laboratory	-	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	Total					
PEL6014	Internet of Things Laboratory	-	-	-	-	-	25	25	50

Course Objectives:

Upon completion of this laboratory course, students will be able to:

1. To develop proficiency in configuring and programming IoT hardware platforms by setting up development environments, interfacing sensors and actuators, and performing basic embedded programming and debugging.
2. To implement data acquisition and device communication mechanisms using wired and wireless connectivity.
3. To design and deploy cloud-connected IoT solutions by integrating devices with IoT platforms for data upload, visualization, and remote control.
4. To create application-level interfaces and data management solutions by developing dashboards, mobile/web applications, and structured databases for IoT data storage and analysis.
5. To apply security and reliability considerations in IoT systems.
6. To design and implement end-to-end IoT applications.

Course Outcomes:

1. Set up IoT development environments and demonstrate proficiency in working with IoT hardware platforms (ESP32, NodeMCU, Raspberry Pi)
2. Implement IoT communication Protocols
3. Develop sensor-actuator integrated systems
4. Integrate and deploy IoT solutions on cloud platforms
5. Design database schemas for IoT data storage, implement SQL queries for analytics,
6. Understand and apply security mechanisms.

Suggested List of Experiments:

Exp. No.	Experiment Title	Experiment Description	Mapped LOs	Duration (Hours)
1	Introduction to IoT Hardware and Development Environment	Familiarization with IoT development boards (ESP32/NodeMCU/Raspberry Pi) Understanding GPIO pins, pin configuration, and specifications Setting up development environment (Arduino IDE/Python) Basic programming: LED blinking, push button interfacing Serial communication and debugging	LO1, LO3	2
2	Sensor Interfacing and Data Acquisition	Interface multiple sensors (DHT11/DHT22, LDR, Ultrasonic, PIR) Read analog and digital sensor data Implement data sampling techniques Display sensor data on serial monitor and LCD/OLED Create sensor data logging system	LO1, LO3	2
3	IoT Communication Protocols Implementation	Configure Wi-Fi connectivity on ESP32/NodeMCU Implement HTTP client for data transmission Setup and configure MQTT broker (Mosquitto/HiveMQ) Publish sensor data using MQTT protocol Subscribe to topics and receive commands Compare HTTP vs MQTT performance	LO2	2
4	Cloud Platform Integration and Data Upload	Create account on IoT cloud platform (ThingSpeak/Blynk/AWS IoT) Configure device credentials and API keys Send real-time sensor data to cloud platform Implement data channels for multiple parameters Setup automatic data logging intervals Visualize data on cloud dashboard	LO4	2
5	Actuator Control and Automation Logic	Interface actuators (Relay, DC Motor, Servo Motor, Buzzer) Implement PWM control for speed/intensity regulation¢ Create automated control logic based on sensor thresholds Build condition-based automation (if-then-else logic) Test local automation without cloud connectivity	LO3	2
6	Remote Device Control via Cloud	Implement bidirectional communication (cloud to device) Subscribe to control commands from cloud platform Control actuators remotely via cloud dashboard Create virtual pins/switches on cloud interface Implement feedback mechanism (device status to	LO2, LO4	2

		cloud) Test remote ON/OFF control of connected devices		
7	Web/Mobile Application Interface Development	Design and develop web-based IoT dashboard (HTML/CSS/JavaScript) Create REST API endpoints for device communication Implement real-time data display using AJAX/WebSocket Develop mobile app interface (Blynk/MIT App Inventor/Flutter) Create control buttons and data visualization widgets Test cross-platform device control	LO4, LO6	2
8	Real-Time Data Analytics with SQL Database	Setup MySQL/PostgreSQL database for IoT data storage Create database schema (tables for sensors, devices, readings) Implement data insertion from IoT devices to database Write SQL queries for data retrieval and analysis Generate reports (average, min, max, trends over time) Create data visualization graphs using database queries Implement data backup and archiving strategies	LO4, LO5	2
9	IoT Security Implementation and Secure Communication	Understand security vulnerabilities in IoT systems through packet sniffing demonstration2Implement TLS/SSL encryption for secure MQTT communication (MQTTS)3Configure username/password authentication on MQTT broker. Implement AES encryption for sensor data before transmission	LO2, LO5	2
10	Short-Range Communication using BLE	Introduction to Bluetooth Low Energy (BLE) architecture and GATT profiles2Configure ESP32 as BLE server and advertise sensor data3Develop BLE client application using mobile app (nRF Connect/custom app)4Implement BLE-based proximity detection and device pairing	LO1, LO2	2

List of Assignments:

Sr No	Assignment/ Tutorial	Hrs
1	**Content from Expt 9 can be part of assignment**	**2**
2	**Content from Expt 10 can be part of assignment**	**2**

Assessment:

Term Work: Term Work shall consist of at least 8 practical's 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 (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
PEL6021	Embedded Systems 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	Total				
PEL6021	Embedded Systems Lab	--	--	--	--	25	25	50

Course Pre-requisites:

1. 2304112-Microcontrollers
2. 2304411-Smart Embedded Systems with ATmega168/328

Course Objectives:

1. Understand the concepts, architecture, and features of real-time operating systems (RTOS) for embedded applications
2. Design and implement multitasking embedded systems using RTOS services
3. Apply task synchronization and inter-task communication mechanisms
4. Analyse scheduling behaviour and real-time performance issues in embedded systems
5. Implement peripheral communication and timing services using RTOS mechanisms
6. Develop reliable, power-efficient, and fault-tolerant embedded systems using RTOS features

Course Outcomes:

After successful completion of the course student will be able to

1. Implement multitasking embedded applications using RTOS services such as tasks and scheduling
2. Apply synchronization and inter-task communication mechanisms in embedded systems
3. Analyse real-time behaviour including scheduling, latency, and resource-sharing issues
4. Evaluate concurrency issues such as priority inversion and deadlock.
5. Implement RTOS timing services and peripheral communication in embedded systems.
6. Design reliable and power-efficient embedded systems using protection and monitoring mechanisms.

Suggested List of Experiments:

1.	Implementation of Multitasking using Free RTOS Tasks
2.	Task Control using Suspend and Resume Mechanisms
3.	Mutual Exclusion using Mutex for Shared Resource Protection

4.	Inter-Task Communication using Message Queues (Producer–Consumer Model)
5.	Priority-Based Preemptive Scheduling Demonstration
6.	Measurement of ISR Latency and Deferred Interrupt Processing
7.	Demonstration of Priority Inversion and Priority Inheritance
8.	Deadlock Demonstration and Deadlock-Avoidance Techniques
9.	Power Optimization in RTOS using Blocking Delays and Tickless Idle Mode
10.	Comparison of Bare-Metal Super Loop and RTOS-Based Design
11.	Software Timer Implementation in RTOS
12.	Implementation of SPI or I²C communication.
13.	Demonstration of Watchdog Timer and Brown-Out Detection for system reliability and recovery

Assessment:

Term Work: Term Work shall consist of at least 8 experiments 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.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
PEL6022	Robotics Lab	-	2	-	-	1	-	1

Course Code	Course Name	Theory				Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Total				
PEL6022	Robotics Lab	--	--	--	--	25	25	50

Prerequisite:

1. VSEC102-C Programming
2. 2303611- C++ and Java Programming

Course Objectives:

1 To learn and understand the basics of fundamentals of robotics systems.

2 To be acquainted with different configuration of robotics system.

3 To design MATLAB program for robotic configuration.

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

1 Identify and understand the unique characteristics and components of robotics systems.

2 Compare and understand various types of robotics systems.

3 Design, simulate and test kinematic equations for robotic systems in MATLAB.

4 Compare and understand various industrial application of robotics systems.

Sr. No	Title of the Experiment	LO
1	Study of configuration of robots and motion of robot manipulator	LO1, LO2
2	Demonstration of various robotic configurations using industrial robot	LO1, LO2
3	Study of pick and place industrial robot	LO1, LO4
4	Study and analysis of robot grippers (includes the problems based on gripper force)	LO1
5	Work Envelope Calculation of 4 axis robotic arm	LO1, LO3
6	Implementation of Coordinate Transformation	LO3

7	Implementation of Homogeneous Coordinate Transformation	LO3
8	MATLAB program for simple kinematics of simple robot configuration	LO3
9	MATLAB program for inverse kinematics of simple robot configuration	LO3
10	Implementation of Trajectory Planning	LO3
11	To demonstrate simple robotic system using Matlab/ MscAdam/ RoboAnalyser software	LO3
12	Edge Detection for Automated Part Boundary Extraction in Robotic Quality Inspection Systems	LO4
13	Detect a Company Logo on Product Packaging in a Store Shelf Image Systems	LO4
14	Obstacle Avoidance Using Reinforcement Learning	LO2, LO4

Virtual Lab Links

1. Mechanisms & Robotics Lab http://vlabs.iitkgp.ernet.in/mr/
2. Robotics Application Lab https://vlab.amrita.edu/?sub=3&brch=271&sim=1642&cnt=3525
3. Bio Inspired Robotics Virtual Lab https://vlab.amrita.edu/?sub=3&brch=257

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practical's 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
PEL6023	Web Design Lab	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical / Oral	Total
		Internal Assessment			End Sem. Exam			
		IA- I	IA-II	Total				
PEL6023	Web Design Lab	--	--	--	--	25	25	50

Course Objectives:

Students will be able to learn:

1. To understand the fundamentals of web technologies and implement version control using Git and GitHub.
2. To design and style interactive web pages usingHTML5, CSS3, and Bootstrap.
3. To develop dynamic web applications using JavaScript, DOM, AJAX, and jQuery.
4. To implement server-side programming using PHP and MySQL for handling web requests and databases.
5. To explore XML and XSL for structured data representation and transformation.
6. To build modern front-end applications using ReactJS with API integration and state management.

Course Outcomes:

Students will be able to achieve the outcome:

1. Demonstrate proficiency in HTML, CSS, and Git for structuring and managing web applications.
2. Apply CSS3 and Bootstrap to create responsive and visually appealing web pages.
3. Develop interactive web applications using Java Script, DOM manipulation, AJAX, and jQuery.
4. Implement server-side applications using PHP and MySQL for dynamic content management.
5. Utilize XML and XSL for structured data processing and transformation.
6. Build modern, scalable web applications using ReactJS with API integration.

List of Experiments

S. No	Experiment	Lab outcome
1	Install Git and create a repository. Perform basic commands: add, commit, status, push. Create and merge a branch.	**LO1**
2	Create a basic HTML5 webpage with headings, lists, tables, images, and forms.	**LO1**
3	Create a simple HTML webpage (Resume/Profile) & Apply CSS styles: colors, fonts, borders, background.	**LO1**
4	Design a simple responsive webpage using CSS3 and Bootstrap (resume or profile page).	**LO2**
5	Write JavaScript programs for arithmetic operations, conditional statements, and loops.	**LO3**
6	Create a webpage where content changes dynamically using DOM and button click.	**LO3**
7	Create a simple form validation page using JavaScript and DOM manipulation.	**LO3**
8	Develop a basic PHP form to collect user data and display it on another page.	**LO4**
9	Connect PHP with MySQL database and perform simple insert and display operations.	**LO4**
10	Implement simple login authentication using PHP sessions and cookie	**LO4**
11	Create an XML file for student or product data and display it in the browser using XSLT.	**LO5**
12	Transform XML data into an HTML table using XSLT.	**LO5**
13	Develop a simple ReactJS Counter application using useState hook.	**LO6**
14	Fetch and display simple data from a public API in React (e.g., weather or quotes).	**LO6**

List of Mini Projects:

1	Build a multi-page responsive portfolio with resume, projects, and contact form (frontend + basic backend storage).	LO1, LO2, LO3
2	Fetch weather data using public API and display dynamically using React.	LO6
3	Task manager app using React hooks and state management.	LO6
4	Digital Library Management System	LO4
5	XML-Based Product Catalog with XSL Styling	LO5

Assessment

At least **08-10 experiments (including Mini Project)** covering the entire syllabus (HTML, CSS3, Bootstrap, JavaScript, DOM, AJAX, jQuery, PHP, MySQL, XML/XSL, and ReactJS) must be conducted **batch-wise** and implemented using standard web development tools such as:

- VS Code / Any Code Editor
- XAMPP / WAMP (for PHP & MySQL)
- Browser Developer Tools
- ReactJS (Node.js environment)
- Git & GitHub for version control

01 Mini Project (Application-Oriented) must be completed in a group of **maximum four students**.
The Mini Project must integrate **frontend, backend, database connectivity, and/or API usage**, covering major course outcomes.

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 (Mini Project) + 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
PEL6024	Network Management in Telecommunication 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	Total				
PEL6024	Network Management in Telecommunication Lab	--	--	--	--	25	25	50

Course Objectives:

1. To introduce packet capture and traffic monitoring techniques using command-line and graphical tools.
2. To measure and analyze network performance parameters such as throughput, delay, packet loss, and bandwidth utilization.
3. To perform network discovery, auditing, and service identification using scanning tools.
4. To configure and use SNMP-based monitoring systems for collecting and visualizing network statistics.
5. To implement fault, availability, and centralized monitoring using industry-standard network management systems.
6. To compare and evaluate multiple networks monitoring tools based on performance, usability, and reporting features.

Course Outcomes:

After successful completion of the course student will be able to

1. Capture and analyze network traffic to identify protocols and basic traffic characteristics.
2. Compute network performance metrics including delay, packet loss, throughput, and bandwidth utilization.
3. Discover network devices and services and perform basic network audits.
4. Collect, store, and visualize SNMP-based network statistics using monitoring and graphing tools.
5. Monitor network availability, faults, and events using centralized network management platforms.
6. Compare network monitoring tools and assess their effectiveness for real-world network management tasks.

List of Experiments:

Week No	List of Experiments	Hrs
01	Packet Capture & Simple Traffic Monitoring using Wireshark • Capture packets on a LAN • Analyse TCP/UDP, identify protocols, extract basic stats Tools: **Wireshark** (opens many monitoring possibilities)	02

02	Traffic Monitoring with tcpdump& Baseline Traffic Metrics
	• Capture traffic via command line
	• Calculate:
	  • Packets per second
	  • Byte counts over time
	  • Throughput (kbps/Mbps)
	Tools: tcpdump, Linux CLI
		02

03	Network Performance Calculation (Delay & Packet Loss)
	• Active ping tests
	• Compute:
	  • Average Delay
	  • Loss % from packet capture
	Concepts: RTT, latency measurement
		02

04	Bandwidth Utilization Monitoring using iftop, nload • Real-time bandwidth usage display • Graph/interpret traffic patterns Tools: iftop, nload	02
05	LAN Scanner & Network Audit with Nmap • Discover hosts & open ports • Identify services running Tools**:** Nmap / Zenmap (graphical)	02
06	Monitoring with SNMP – Basics • Configure SNMP agent on a Linux host • Use SNMP queries to poll basic metrics • Record interface counters, CPU utilization Tools: SNMP utilities (snmpwalk, snmpget)	02
07	Plotting Network Statistics using MRTG / RRD • Collect SNMP stats periodically • Visualize interface traffic trends Tools: MRTG**,** RRDTool	02
08	Graphical Monitoring using Cacti • Discover devices using SNMP	02

	• Generate traffic graphs • Extract average/peak throughput values Tools: Cacti	
09	. Real-Time Fault & Availability Monitoring with Nagios/Icinga • Monitor host availability • Configure alerts for status changes Tools: Nagios Core / Icinga	02
10	Network Device Discovery & Map using Netdisco • Discover network devices (switches/routers) • Show connectivity maps Tool: Netdisco .	02

11	. Centralised Monitoring using Zabbix
	• Add host(s)
	• Monitor:
	  • SNMP metrics
	  • Network uptime
	  • Traffic history
	Tool: Zabbix
		02

12	Flow-Based Traffic Measurement (NetFlow / sFlow) • Collect flow records (e.g., with sample tools) • Analyse traffic distribution Concepts: NetFlow/sFlow traffic analysis	02
13	Syslog Based Monitoring & Analysis • Configure remote syslog • Filter/interpret significant events Tools: rsyslog / syslog-ng	02
14	Combined Dashboard with OpenNMS / LibreNMS • Import SNMP & syslog sources • Visualise metrics on a central dashboard Tools: Open NMS/LibreNMS	02

15	. Comparative Performance Evaluation Across Tools
	• Select any *3 monitoring tools* (e.g., Cacti, Zabbix, Nagios)
	• Compare:
	  • Accuracy of traffic metrics
	  • Ease of use
	  • Graphing capabilities
		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.

List of Assignments: Based on above syllabus Subject in charge can give two assignments to the students.

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)

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