Lokmanya Tilak Jankalyan Shikshan Santha's

Lokmanya Tilak College of Engineering

Sector 4, Vikas Nagar, Koparkhairane, Navi Mumbai 400709

An Autonomous Institute Affiliated to University of Mumbai

Department of Electronics & Telecommunication Engineering

CURRICULUM STRUCTURE

For

THIRD YEAR ENGINEERING

(BASED ON NEP 2020)

w.e.f. A.Y. 2026-27

Approved by Board of Studies on 02/05/2026

Approved by Academic Council on 22/05/2026

Department of Electronics & Telecommunication Engineering

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w.e.f. A.Y. 2026-27

Preface

Lokmanya Tilak College of Engineering (LTCE) is founded by a Nagpur-based trust known as Lokmanya Tilak Jankalyan Shikshan Sanstha (LTJSS). The Sanstha was established in 1983, by Honourable Dr. Satish Chaturvedi. At present, there are 28 educational institutes run by the Sanstha in Nagpur. The Sanstha derives its philosophy from the magnanimous mathematician, educationist, social reformer Lokmanya Bal Gangadhar Tilak, who dedicated his life for the cause of Swaraj. Lokmanya Tilak College of Engineering was established in 1994, approved by the All-India Council for Technical Education, New Delhi, recognised by the Govt. of Maharashtra, accredited by NAAC with 'A' grade and is affiliated to the University of Mumbai. Within the span of 30 years of its inception, LTCE has grown leaps and bounds in terms of popular courses being offered at U.G., P.G. and Ph.D. level. Four of its branches viz., Computer, Mechanical, Electrical and Electronics and Telecommunications Engg. have been accredited by NBA. The Institute runs the Under-graduate Programmes in Mechanical Engineering, Computer Engineering, Electronics & Telecommunication Engineering, Electrical Engineering, Computer Science & Engineering (Data Science), Computer Science & Engineering (Artificial Intelligence & Machine Learning) and Computer Science & Engineering (IoT & Cyber Security Including Blockchain Technology). Institute also offers Doctoral Programmes in Mechanical Engineering and Computer Engineering. LTCE stands steadfast in its mission of continuing efforts for the betterment of its students and society.

The National Education Policy 2020, recently implemented by the Government of India, envisions providing quality education to all young people, with the primary goal of nurturing well-rounded, thoughtful, and creative individuals. NEP 2020 also emphasizes the importance of developing character, ethical values, constitutional principles, intellectual curiosity, scientific temper, creativity, and other related virtues. The Government of Maharashtra has instructed autonomous colleges to update their curriculum and begin implementing the National Education Policy (NEP) 2020. We are fully committed to ensuring the effective and meaningful adoption of NEP 2020 in its true essence. At "Lokmanya Tilak College of Engineering", the holistic development of learners has always been our top priority and central focus. LTCE embraced the NEP philosophy as early as 2022 wherein we have introduced the concept of Honors and Minors programs on emerging fields as per the guidelines of University of Mumbai and in 2024, we proudly graduated our first batch under this holistic curriculum. The autonomous curriculum for 2024-28 is structured in line with the recommendations of NEP 2020, AICTE, and UGC. It now includes courses in emerging technologies and multidisciplinary areas to ensure relevance to industry and practical applications. Greater focus has been placed on experiential learning to move away from rote memorization.

Sd/-	Sd/-	Sd/-
Dr. Ravindra Duche	**Dr. Sheeba P. S.**	**Dr. Subhash K. Shinde**
BoS Chairman, EXTC	**Dean, Academics & Research**	**Principal**

Illustrative Semester wise Credit distribution structure for Four Year UG Engineering Program – One Major, One Multidisciplinary Minor as per Maharashtra State Govt. Resolution:

Courses		Semester								Total Credits
		I	II	III	IV	V	VI	VII	VIII	
Basic Science Course	BSC/ESC	6-8	8-10							14-18
Engineering Science Course		8-10	4-6							12-16
Programme Core Course (PCC)	Program Courses		2	8-10	8-10	10-12	8-10	4-6	4-6	44-56
Programme Elective Course (PEC)						4	8	2	6	20
Multidisciplinary Minor (MD M)	Multidisciplinary Courses			2	2	4	2	2	2	14
Open Elective (OE) Other than a particular program				4	2	2				8
Vocational and Skill Enhancement Course (VSEC)	Skill Courses	2	2		2		2			8
Ability Enhancement Course (AEC -01, AEC-02)	Humanities Social Science and Management (HSSM)	2			2					4
Entrepreneurship/Economics/ Management Courses				2	2					4
Indian Knowledge System (IKS)			2							2
Value Education Course (VEC)				2	2					4
Research Methodology	Experiential Learning Courses								4	4
Comm. Engg. Project (CEP)/Field Project (FP)				2						2
Project									4	4
Internship/ OJT								12		12
Co-curricular Courses (CC)	Liberal Learning Courses	2	2							4
Total Credits (Major)		**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**160-176**

Definition of Credit:

1 Hr. Lecture (L) per week	1 Credit
1 Hr. Tutorial (T) per week	1 Credit
2 Hr. Practical (P) per week	1 Credit
1 Hr. Practical (P) per week	0.5 Credit

Credit Requirements for Award of Degree:

a) A total of 167 credits are required for a student to be eligible for the award of an **Undergraduate Degree in Engineering**, including a Multi-Disciplinary Minor, in accordance with the Government of Maharashtra GR dated 04/06/2024.

b) A student shall be eligible for the award of an **Undergraduate Degree** with **Honours/Minor** in Emerging Areas upon earning an additional **18 credits**.

Multiple Exits:

Students will have the flexibility to enter a programme in odd semesters and exit a programme after the successful completion of even semesters as per their future career needs.

Distribution of Credits:

Level	Exit After Semester	Minimum Credits Required	LTCE Credits	Qualification Title	Additional Credit requirements
4.5	II (First Year)	40	44	One Year UG Certificate in relevant discipline	8 credits through Skill-based vocational courses (4 Credits) and Internship/ Apprenticeship/ Project (4 Credits).
5.0	IV (Second Year)	80	86	Two Years UG Diploma in relevant discipline	**8 credits** through Skill-based vocational courses (4 Credits) and Internship/ Apprenticeship/ Project (4 Credits).
5.5	VI (Third Year)	120	127	Three Years B. Voc. in the relevant Discipline	**8 credits** through Skill-based vocational courses (4 Credits) and Internship/ Apprenticeship/ Project (4 Credits).
6.0	VIII (Fourth Year)	160	167	B.Tech. in major discipline with multidisciplinary minor	-----
6.0	VIII (Fourth Year)	160+18= 178	167+18= 185	**B.Tech**. in major discipline with double minor (Multidisciplinary and Emerging minor)	--------

Type of Course	**Course Code**	**No. of Credits as per Maharashtra Govt.**	**No. of credits as per LTCE**
Basic Science Course	BSC	14-18	**16**
Engineering Science Course	ESC	12-16	**14**
Programme Core Course	PCC	44-56	**49**
Programme Elective Course	PEC	20	**19**
Multidisciplinary Minor	MDM	14	**14**
Open Elective (OE) Other	OE	8	**08**

than a particular program			
Vocational and Skill Enhancement Course	VSEC	8	**10**
Ability Enhancement Course (AEC -01, AEC-02)	AEC	4	**03**
Entrepreneurship/Economics/ Management Courses	EEMC	4	**04**
Indian Knowledge System (IKS)	IKS	2	**02**
Value Education Course (VEC)	VEC	4	**04**
Research Methodology	ELC	4	**03**
Comm. Engg. Project (CEP)/Field Project (FP)	ELC	2	**02**
Project	ELC	4	**04**
Internship/ OJT	ELC	12	**12**
Co-curricular Courses (CC)	CC	4	**03**
Total Credits (Major)		**160-176**	**167**
Total Credits (Major+ Honors/Minors)		**178-194**	**167+18=185**

Abbreviations:

AEC	Ability Enhancement Course
AEL	Ability Enhancement Laboratory
BSC	Basic Science Course
BSL	Basic Science Laboratory
CEP	Common Engineering Project
CC	Co-curricular courses
CIE	Continuous Internal Evaluation
ESC	Engineering Science Course
ESE	End Semester Exam
ESL	Engineering Science Laboratory
IKS	Indian Knowledge System
L	Lecture

MDM	Multidisciplinary Minor
MSE	Mid Semester Exam
OE	Open Elective
P	Practical
PCC	Programme Core Course
PCL	Programme Core Laboratory
PEC	Programme Elective Course
T	Tutorial
VEC	Value Education Course
VSEC	Vocational and Skill Enhancement Course

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Department of Electronics & Telecommunication Engineering

Third Year Engineering Scheme: Semester V (w.e.f. AY 2026-27)

Course Code	Course Name	Teaching Scheme		Credit Assigned		Total Credits	Examination Scheme					
							Internal Assessment		End Semester Exam		Oral &/ Practical	Total
		L	P	L	P		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)	Marks	Duration (Hrs)		
ETPCC501	Discrete Time Signal Processing	3	--	3	--	3	20	20	60	2	--	100
ETPCC502	Digital VLSI	3	--	3	--	3	20	20	60	2	--	100
ETPCC503	Network Theory & Control System	3	--	3	--	3	20	20	60	2	--	100
ETPEC501X	Program Elective Course	3	--	3	--	3	20	20	60	2	--	100
CEMDM501	Multidisciplinary Minor Course II	3	--	3	--	3	20	20	60	2	--	100
ETVSEC501	Computational Laboratory	--	2*+2	--	2	2	--	50	--	--	25	75
ETPCL501	Discrete Time Signal Processing Lab	--	2	--	1	1	--	25	--	--	25	50
ETPCL502	Digital VLSI Lab	--	2	--	1	1	--	25	--	--	25	50
ETPECL501X	Program Elective Lab	--	2	--	1	1	--	25	--	--	25	50
CEMDML501	Multidisciplinary Minor Lab II	--	2	--	1	1	--	25	--	--	--	25
Total		**15**	**12**	**15**	**6**	**21**	**100**	**250**	**300**	**10**	**100**	**750**

*** e- learning course**

ETPEC501x : Program Elective Course I	**ETPEC5011:** Computer Communication Networks	**ETPEC5012:** IT Infra & Security	**ETPEC5013:** Radar Engineering
ETPEL501x : Program Elective Lab I	**ETPECL5011:** Computer Communication Networks Lab	**ETPECL5012:** IT Infra & Security Lab	**ETPECL5013:** Radar Engineering Lab

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Department of Electronics & Telecommunication Engineering

Third Year Engineering Scheme: Semester VI (w.e.f. AY 2026-27)

Course Code	Course Name	Teaching Scheme		Credit Assigned		Total Credits	Examination Scheme					
							Internal Assessment		End Semester Exam		Oral &/ Practical	Total
		L	P	L	P		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)	Marks	Duration (Hrs)		
ETPCC601	Electromagnetic and Antenna	3	--	3	--	3	20	20	60	2	--	100
ETPCC602	Image Processing and Machine Vision	3	--	3	--	3	20	20	60	2	--	100
ETPEC601X	Program Elective Course 1	3	--	3	--	3	20	20	60	2	--	100
ETPEC602X	Program Elective Course 2	3	--	3	--	3	20	20	60	2	--	100
CEMDM601	Multidisciplinary Minor Course III	3	--	3	--	3	20	20	60	2	--	100
ETPCL601	Electromagnetic and Antenna Lab	--	2	--	1	1	--	25	--	--	25	50
ETPCL602	Image Processing and Machine Vision Lab	--	2	--	1	1	--	25	--	--	25	50
ETPEL601X	Program Elective Lab	--	2	--	1	1	--	25	--	--	--	25
CEMDML601	Multidisciplinary Minor Lab III	--	2	--	1	1	--	25	--	--	--	25
ETCEP601	Mini Project II	--	2	--	1	1	--	25	--	--	25	50
Total		**15**	**10**	**15**	**5**	**20**	**100**	**225**	**300**	**10**	**75**	**700**

ETPEC601x : Program Elective Course II	**ETPEC6011:** Wireless Network	**ETPEC6012:** Natural Language Processing	**ETPEC6013:** Satellite Communication
ETPEL601x : Program Elective Lab II	**ETPECL6011:** Wireless Network Lab	**ETPECL6012:** Natural Language Processing Lab	**ETPECL6013:** Satellite Communication Lab
ETPEC602x : Program Elective Course III	**ETPEC6021:** 5G Technology	**ETPEC6022:** Machine Learning	**ETPEC6023:** Robotics

Multidisciplinary Minor (MDM) (14 Credits)

Semester	Computer Engineering (CE)	Electronics & Telecommunication Engineering (ET)	Artificial Intelligence & Robotics (AR)	Internet of Things (IT)	Mechanical Engineering (ME)	Electrical Engineering (EE)
IV	**CEMDM401:** Data Structure and Algorithms	**ETMDM401:** Microprocessor and Microcontroller	**ARMDM401:** Artificial Intelligence	**ITMDM401:** Internet of Things and Applications	**MEMDM401:** Basics of Mechanical Engineering	**EEMDM401:** Elements of Electrical System
	CEMDML401: Data Structure and Algorithms Lab	**ETMDML401:** Microprocessor and Microcontroller Lab	**ARMDML401:** AI Lab	**ITMDML401:** Internet of Things Lab	**MEMDML401:** Mechanical Engineering Lab	**EEMDML401:** Elements of Electrical System Lab
V	**CEMDM501:** Database Management System	**ETMDM501:** Digital Communication & Sensor Technology	**ARMDM501:** Mechatronics	**ITMDM501:** Sensors, Actuators and Transducers	**MEMDM501:** Conventional & Renewable Energy Sources	**EEMDM501:** Special Machines and Smart grid
	CEMDML501: Database Management System Lab	**ETMDML501:** Digital Communication & Sensor Technology Lab	**ARMDML501:** Mechatronics Lab	**ITMDML501:** Sensors, Actuators and Transducers Lab	**MEMDML501:** Renewable Energy Sources Lab	**EEMDML501:** Special Machines and Smart grid Lab
VI	**CEMDM601:** Big Data computing	**ETMDM601:** Digital Image Processing	**ARMDM601:** Robotics	**ITMDM601:** Microcontrollers and Application	**MEMDM601:** Automobile System	**EEMDM601:** Electric Vehicle Technology
	CEMDML601: Big Data computing Lab	**ETMDML601:** Digital Image Processing Lab	**ARMDML601:** Robotics Lab	**ITMDML601:** Microcontrollers Lab	**MEMDML601:** Automobile Lab	**EEMDML601:** Electric Vehicle Technology Lab
VII	**CEMDML701:** Web Design Lab	**ETMDML701:** Mobile Computing Lab	**ARMDML701:** Predictive Maintenance Lab	**ITMDML701:** PLC and SCADA Lab	**MEMDML701:** 3D Printing Lab	**EEMDML701:** Design Management Auditing of Electrical System Lab

Open Elective Courses (OE) (8 Credits)

Semester	Course Code	Course Name
III	OE3011	Biology for Engineers
	OE3012	Indian Constitution and Governance
	OE3013	Human Psychology
	OE3014	Disaster Management and Mitigation
IV	OE4011	Human Resource Management
	OE4012	Corporate and Cyber Laws
	OE4013	Stock Market and Personal Finance
	OE4014	Nutrition Literacy and Health
VIII	OE8011	Intellectual Property Rights (IPR) and Patents
	OE8012	Risk Management
	OE8013	Economics for Engineers
	OE8014	Innovation and Startups

Department of Electronics & Telecommunication Engineering

Third Year Engineering Curriculum: Semester V

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ETPCC501	Discrete Time Signal Processing	20	20	60	1	2	100	

Prerequisite:	
Course Objectives: The course aims to	
1	Develop a thorough understanding of discrete Fourier transform and its use in spectral analysis and frequency domain filter designing.
2	Design and realize IIR filters, gain an appreciation for the trade-offs necessary in the filter design and to evaluate the effects of finite word lengths on the filters.
3	Design and realize FIR filters, gain an appreciation for the trade-offs necessary in the filter design and to evaluate the effects of finite word lengths on the filters.
4	Describe applications of digital signal processing in the field of biomedical and audio signal processing.
Course Outcomes: Learners will be able to	
1	Understand the concepts of discrete-time Fourier transform, fast Fourier transform and apply in system analysis.
2	Design digital IIR filters to satisfy the given specifications and evaluate the frequency response and pole zero representations to choose a particular filter for the given application.
3	Design digital FIR filters to satisfy the given specifications and evaluate the frequency response and pole zero representations to choose a particular filter for the given application.
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, algorithms in applications related to the field of biomedical and audio signal processing.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Discrete Fourier Transform & Fast Fourier Transform**	9	CO1
	Discrete Fourier transform (DFT), DFT as a linear transformation, Properties of the DFT, Relationship of the DFT to other transforms, Filtering of long data sequences: Overlap-Save and Overlap-Add Method. Fast Fourier Transform: Radix-2 Fast Fourier Transforms (FFT), Radix-2 decimation in time and decimation in frequency FFT algorithms, Inverse FFT.		
	Self-Learning Topic: Composite Radix		
02	**IIR Digital filters**	9	CO2
	LTI systems as frequency-selective filters like low pass, high pass and all-pass filters, Analog filter approximations (Butterworth). Mapping from s-plane to the z-plane - impulse invariant and bilinear		

	transformation, Design of IIR digital filters (Butterworth) from analog filters using impulse invariant and bilinear transformation techniques, Analog and digital frequency transformations.		
03	**FIR Digital Filters** Characteristics of linear phase FIR digital filters, Symmetric and antisymmetric FIR filter, Location of the zeros of linear phase FIR filters, Minimum, maximum and mixed phase systems Design of FIR filters using Window techniques (Rectangular, Hamming, Hanning), Design of FIR filters using Frequency Sampling Technique –Type I low pass filter design, Comparison of IIR and FIR filters.	**9**	**CO3**
04	**Digital Filter Structures** Realization structures for FIR systems: Linear realization, Direct form I&II, Cascade and Parallel form structures. Realization structures for IIR systems: Linear realization, Direct form I&II, Cascade and Parallel form structures.	**6**	**CO4**
05	**Finite Word Length Effects in Digital Filters** Rounding and truncation errors, Quantization error, Output noise power from a digital system, Product quantization, Coefficient quantization error and zero input limit cycle.	**5**	**CO5**
06	**Applications of Digital Signal Processing** Application of DSP for ECG and EEG signals analysis. Application of DSP for echo cancellation and sub-band coding of speech signal.	**4**	**CO6**
	TOTAL Hrs.	**42**	

Text Books:

1. Proakis J., Manolakis D., "*Digital Signal Processing*", 4th Edition, Pearson Education.
2. A Nagoor Kani “Digital Signal Processing”, 2nd Edition. Tata Mc Graw Hill Education Private Limited.
3. Sanjit K. Mitra, “Digital Signal Processing – A Computer Based Approach “, 4th Edition McGraw Hill Education (India) Private Limited, 2013

References:

1. Emmanuel C. Ifeachor, Barrie W. Jervis,” Digital Signal Processing”, A Practical Approach, Pearson Education.
2. Oppenheim A., Schafer R., Buck J., "Discrete Time Signal Processing", 2nd Edition, Pearson Education, 3rd Edition, 2010.
3. S Salivahan, C Gnanapriya, “Digital Signal Processing”, Mc Graw Hill Education (India) limited, 4th Edition, 2015.

NPTEL / Swayam Course:

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/108105055

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

Assignment: 5 Marks

1. Quiz/Open book test/Presentation: 10 Marks
2. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ETPCC502	**Digital VLSI**	20	20	60	1	2	100	

Prerequisite: Digital System Design , Electronics Devices and Integrated Circuits	
Course Objectives: The course aims to	
1	Understand process flow of VLSI Design.
2	Describe MOSFET operation from VLSI design perspective.
3	Learn VLSI design performance metric.
4	Design, implement and verify combinational and sequential logic circuits using various MOS design styles.
Course Outcomes: Learners will be able to	
1	Know various tools and processes used in VLSI Design.
2	Explain working of various CMOS combinational and sequential circuits used in VLSI Design.
3	Derive expressions for performance parameters of basic building blocks like CMOS inverter.
4	Relate performance parameters with design parameters of VLSI circuits.
5	Select suitable circuit and design style for given application.
6	Design and realize various combinational and sequential circuits for given specifications.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Review of MOSFET operation and Fabrication** Overview of VLSI Design Flow, Review of MOSFET operation, MOSFET Capacitances, MOSFET scaling. Fabrication process flow of NMOS and CMOS. Lambda based NMOS and CMOS design rules.	8	CO1
02	**Combinational CMOS Logic Circuits** CMOS inverter operation, Voltage Transfer characteristics (VTC), Noise Margins. Design of CMOS Inverter, Layout of CMOS Inverter. Realization of CMOS NAND and NOR gate.	7	CO2
03	**MOS Design Logic Styles** Static CMOS, Pass Transistor Logic, Transmission Gate, Pseudo NMOS, Dynamic Logic, Domino Logic, C2MOS. Clocked CMOS SR Latch, CMOS JK Latch and D Flip flop realization using design styles.	9	CO3
04	**Semiconductor Memories** ROM array, 6T-SRAM (operation, design strategy, leakage currents), Layout of 6T SRAM. Operation of 1T and 3T DRAM Cell. Flash Memory, NAND and NOR flash memory.	7	CO4
05	**Data path and system design issues** Ripple carry adder, CLA adder, Carry save adder, Carry select adder, Carry skip adder. Array Multiplier. On chip clock generation and distribution, Interconnect scaling and crosstalk.	6	CO5
06	**RTL Design** High Level state machines, RTL design process. RTL design of Soda dispenser machine, FIR Filter.	5	CO6
	Total	42	

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.

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

NPTEL / Swayam Course:

1. https://nptel.ac.in/courses/117/101/117101058
2. https://nptel.ac.in/courses/108107129

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ETPCC503	**Network Theory & Control System**	20	20	60	1	2	100	

Prerequisite: 1. Basic Electrical Engineering 2. Engineering Mathematics-II	
Course Objectives: The course aims to:	
1	Evaluate the circuits using network theorems and analyze them using graph theory
2	Understand two port networks and synthesize passive network by various methods
3	Apply fundamental concepts of control system such as mathematical modeling, time response and frequency response.
4	Apply concepts of stability and its assessment criteria.
Course Outcomes: Learners will be able to	
1	Apply their knowledge in analyzing circuits by using network theorems.
2	Determine the various parameters of two port network and relation between them.
3	Analyze the circuit using graph theory
4	Synthesize the network using RC and LC passive elements
5	Explain stability of systems in time domain and frequency domain.
6	Determine stability of given system using appropriate criteria.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Electrical circuit analysis**	**7**	CO1
	Circuit Analysis: Analysis of Circuits with and without dependent sources using generalized loop and node analysis, super mesh and super node analysis technique. Circuit Theorems: Superposition, Thevenins, Norton's and Maximum Power Transfer Theorems (Use only DC source).		
	Self learning: KVL and KCL		
	Graph Theory		

02	Objectives of graph theory, linear oriented graphs, graph terminologies, Matrix representation of a graph: Incidence matrix, Circuit matrix, Cut-set matrix, reduced Incident matrix, Tieset matrix, f-cutset matrix. Relationship between sub matrices A, B & Q. KVL & KCL using matrix.	**7**	**CO2**
03	**Two port Networks**		
	Parameters: Open Circuits, short Circuit, Transmission and Hybrid parameters, relationship among parameters, conditions for reciprocity and symmetry, Interconnection of Two-Port networks, T & π representation.	**6**	**CO3**
04	**Synthesis of RLC circuits**		
	Positive Real Functions: Concept of positive real function, necessary and sufficient conditions for positive real functions, Synthesis of LC, RC & RL Circuits: properties of LC, RC & RL driving point functions, LC, RC & RL network Synthesis in Cauer-I & Cauer-II , Foster-I & Foster-II forms (Up to Two Loops only).	**7**	**CO4**
05	**Introduction to control system Analysis**		
	Introduction: Open and closed loop systems, Transfer function model, Block diagram reduction techniques and Signal flow graph, Introduction to transient and steady state response of first and second order system, steady state error.	**7**	**CO5**
06	**Stability Analysis**		
	Concept of stability: Routh and Hurwitz stability criterion, Bode Plot: Magnitude and phase plot, Method of plotting Bode plot, Nyquist Criterion: Concept of Polar plot and Nyquist plot, Nyquist stability criterion. .	**8**	**CO6**
	Total	**42**	

Text Books:

1. Franklin F Kuo, "Network Analysis and Synthesis", Wiley Toppan, 2nd ed. 1966.
2. M E Van Valkenburg, "Network Analysis", Prentice-Hall of India Pvt Ltd, New Delhi, 26th Indian Reprint, 2000.
3. Nagrath, M.Gopal, "Control System Engineering", Tata McGrawHill.
4. K.Ogata, "Modern Control Engineering, Pearson Education", IIIrd edition.

References:

1. A. Chakrabarti, "Circuit Theory", Dhanpat Rai & Co., Delhi, 6th Edition.
2. A. Sudhakar, Shyammohan S. Palli "Circuits and Networks", Tata McGraw-Hill education.
3. Smarajit Ghosh "Network Theory Analysis & Synthesis", PHI learning.

4. K.S. Suresh Kumar, “Electric Circuit Analysis” Pearson, 2013.
5. D. Roy Choudhury, “Networks and Systems” , New Age International, 1998
6 Gopal M., “Control Systems Principles and Design”, Tata McGraw Hill Publishing Co. Ltd.New Delhi, 1998.
7. Benjamin C.Kuo, “Automatic Control Systems, Eearson education”, VIIthedition
8. Normon, “Control System Engineering”, John Wiley & sons, 3rdedition.

NPTEL / Swayam Course:
1. Course: Basic Electrical Circuits By Prof. Nagendra Krishnapura (IIT Madras);
https://swayam.gov.in/nd1_noc20_ee64/preview
2. Course: Control Systems By Prof. C. S. Shankar Ram (IIT Madras);
https://swayam.gov.in/nd1_noc20_ee90/preview

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)
Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)
1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)
End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ETPEC5011	Computer Communication Networks	20	20	60	1	2	100	

Prerequisite: Communication Engineering	
Course Objectives: The course aims to	
1	Understand and recognize the layer-wise functions, services, data formats, protocols, hardware devices and addresses in the TCP/IP architecture
2	Learn network layer services and protocols
3	Describe different addressing and routing schemes.
4	Know flow and error control schemes.
Course Outcomes: Learners will be able to	
1	Demonstrate the concepts of data communication and compare ISO - OSI model with TCP/IP
2	Analyze the flow control, error control and the medium access control techniques
3	Analyze various routing algorithms and protocols at network layer.
4	Design the network using IP addressing and subnetting / super netting schemes.
5	Analyze connection oriented and connectionless services
6	Explore protocols at application layer

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Network Architectures and Protocol Layers** Protocols and standards, OSI reference model. TCP/IP architecture: protocol suite, comparison of OSI and TCP/IP Layer wise network hardware devices (NIC, Repeaters, Hubs, Bridges, Switches, Routers, Gateway and their comparison) Addressing: physical / logical /port addressing/socket addressing.	7	CO1
02	**Data Link Layer** Data link services: Framing, Flow control, Error control	8	CO2

	ARQ methods: transmission efficiency, Piggybacking High Level Data Link Control (HDLC) configurations, Frame formats, HDLC bit stuffing and de-stuffing. Medium Access Control Protocols: ALOHA, Slotted ALOHA, CSMA, CSMA/CD		
03	**Network Layer and IP Addressing** Introduction to data networks and packet switching principles. Network layer services and functions. Internet Protocol: Principles of Internetworking, requirements, IPv4 packet, IPv4 addressing (classfull and classless (CIDR)), IPv6 Addressing, Transition from IPV4 to IPV6. Comparison of IPv4 and IPv6.	**8**	**CO3**
04	**Routing Protocols** Routing in Packet Switching Networks: Characteristics, Routing strategies. Routing algorithms: Link state Routing, Distance vector Routing and Path vector routing, Routing protocols: RIP, OSPF and BGP. Sub netting, VLSM, and NAT. Introduction to ICMP, ARP, RARP	**8**	**CO4**
05	**Transport Layer** Connectionless and Connection–oriented services at transport layer, Transmission. Control Protocol (TCP): TCP Services, TCP Segment, TCP three way handshake. User datagram Protocol (UDP), UDP Services, UDP Datagram. TCP and UDP checksum calculation. Flow control, error control and congestion control	**7**	**CO5**
06	**Application Layer** Introduction to Application layer Protocols: HTTP, FTP, DNS, SMTP, TELNET and DHCP.	**4**	**CO6**
	Total	**42**	

Text books:

1. Data Communications and Networking – Behrouz A. Forouzan, Fifth Edition TMH, 2013.
2. Computer Networks -- Andrew S Tanenbaum, 5th Edition, Pearson Education, 2013.
3. J J. F. Kurose and K. W. Ross," Computer Networking: A Top-Down Approach", Addison Wesley, 5th Edition, 2010

Reference books:

1. Alberto Leon Garcia, "Communication Networks", McGraw Hill Education, Second Edition, Fourth Edition, 2008.
2. An Engineering Approach to Computer Networks-S.Keshav, 2nd Edition, Pearson Education, 2015.
3. Understanding communications and Networks, 3rd Edition, W.A.Shay, Cengage Learning
4. Data and Computer Communications, William Stallings, 10 th Edition, Pearson Education, 2014.

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ETPEC5012	IT Infra & Security	20	20	60	1	2	100	

Prerequisite: Principles of Communication	
Course Objectives: The course aims to	
1	Explain the basics of IT Infrastructure and its Management.
2	Develop underlying principles of infrastructure security.
3	Name the software vulnerabilities and attacks.
4	Explain the protection mechanisms for operating systems and database security.
Course Outcomes: Learners will be able to	
1	Describe IT Infrastructure and its Management
2	Discuss concept of Information securities.
3	Summarize the concepts of vulnerabilities, attacks, and protection mechanisms.
4	Analyze software vulnerabilities and attacks on databases and operating systems.
5	Describe the need for security protocols in the context of wireless communication.
6	Analyze different attacks on open web applications and web service.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Overview of Networks and IT Infrastructure** Overview of OSI and TCP/ IP Networks, introduction to IP Addressing scheme Introduction to Networking Components**.** Information Technology, Design Issues of IT Organizations and IT Infrastructure, Information System Design Process. IT Infrastructure Management, Challenges in IT Infrastructure Management, Determining Customers, Requirements. Security controls and safeguards, IT security Plans.	09	CO1

02	**Introduction to Information Security** Cyber-attacks, Vulnerabilities, Defense Strategies and Techniques, Authentication Methods- Password, Token and Biometric, Access Control Policies and Models (DAC, MAC, RBAC, BIBA, Bell La Padula). Authentication and Access Control Services- RADIUS, TACACS, and TACACS+	**07**	**CO2**
03	**Software Vulnerabilities** Buffer overflow, Format String, Cross-Site Scripting, SQL Injection. Malware: Viruses, Worms, Trojans, Logic Bomb, Bots, Rootkits.	**04**	**CO3**
04	**Operating System and Database Security** Introduction to operating system security, system security planning, Application security. Linux/ Unix security, security maintenance, Windows security, Security maintenance. Database Security Requirements, Reliability and Integrity, Sensitive Data, Inference Attacks, Multilevel Database Security.	**09**	**CO4**
05	**Wireless Security** The need for Wireless Network Security, Attacks on Wireless Networks, Security services. WEP & WPA protocols. Mobile IP, Virtual Private Network (VPN): PPTP, L2TP, IPSec.	**06**	**CO5**
06	**Web Security** Introduction: Transport Protocol and Data Formats, Web Browser, Threat Model Authenticated Sessions: Cookie Poisoning, Cookies and Privacy, Making Ends Meet Code Origin Policies, Cross-Site Scripting: Cookie Stealing, Defending against XSS, Cross-Site Request Forgery, JavaScript Hijacking.	**07**	**CO6**
	Total	**42**	

Text books:

1. Gupta, "IT Infrastructure & Its Management", First Edition, Tata McGraw-Hill Education.
2. Computer Security Principles and Practice, William Stallings, Sixth Edition, Pearson Education.
3. Computer Security, Dieter Gollmann, Third Edition, Wiley Publications.
4. Data Communications and Networking, Forouzan, Fourth Edition, Mc Graw Hill Publication.
5. Wireless Networks, P. Nicopolitidis, M.S. Obaidat, G.I Papadimitriou, A.S Pomportsis, Wiley Publications

Reference books:

1. Security in Computing, Charles P. Pfleeger, Fifth Edition, Pearson Education.
2. CCNA Security Study Guide, Tim Boyle, Wiley Publications.
3. Introduction to Computer Security, Matt Bishop, Pearson.

4. https://grow.google/intl/ALL_in/cybersecurity-course/
5. http://acl.digimat.in/nptel/courses/video/106106129/106106129.html

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ETPEC5013	Radar Engineering	20	20	60	1	2	100	

Prerequisite: Communication Fundamentals	
Course Objectives: The course aims to	
1	Apply generalized concept of RADAR.
2	Analyse Radar equations.
3	Illustrate different types of radar
4	Design RADAR transmitters and receivers for given conditions
Course Outcomes: Learners will be able to	
1	Apply generalized concept of RADAR.
2	Analyse different problems using radar equations.
3	Describe different types of radar for specific application.
4	Explain concept of tracking radar.
5	Evaluate the design constraints for transmitter & receiver.
6	Analyse RADAR target from given specification.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Radar** Basics Radar, Radar equation, Block Diagram, Radar Frequencies & Applications of Radar	7	CO1
02	**Radar Equation** Detection of signal in noise, Receiver Noise and Signal-to-noise Ratio, Probability of detection and false alarm: Simple , complex Targets, Pulse Repetition Frequency	8	CO2
03	**MTI and Pulse Doppler Radar** Introduction to Doppler and MTI radar, Doppler frequency shift, Simple CW Doppler radar, MTI radar block diagram, Delay line canceller, Moving-target-detection, Pulse Doppler radar	7	CO3
04	**Tracking Radar**	7	

	Mono-pulse tracking, Conical scan and sequential lobbing, Limitation of tracking accuracy, Low angle tracking		**CO4**
05	**Radar Transmitters** Radar RF power sources: Klystron, Travelling wave tube, Solid state RF power source: low power transmitter, high power transmitter, Advantages of solid state RF power source, Magnetron: coaxial magnetron, Crossed field amplifiers: CFA operation, modulating a CFA, system implementation	**7**	**CO5**
06	**Radar Receivers** Receiver noise figure, Super heterodyne Receiver, Radar Display, Types of displays	**6**	**CO6**
	Total	**42**	

Text Books:

1. Merrill Skolnik, "Introduction to RADAR Systems", Tata McGraw Hill, Third Edition.
2. Merrill Skolnik, "Radar Handbook", Tata McGraw Hill, Second Edition
3. Kulkarni M "Radar Engineering", Umesh Publications, New Delhi
4. Sharma K.K. "Radar, Sonar and Navigation engineering" Katsons Publications, New Delhi

References Books:

1. Mark A. Richards, James A. Scheer, William A. Holm, "Principles of Modern Radar: Basic Principals", SciTech Publishing Inc.
2. Simon Kingsley, Shaun Quegon, "Understanding Radar Systems", Scientech Publishing.
3. G. S. N. Raju, "Radar Engineering and Fundamentals of Navigational Aids", I. K International publishing House Pvt. Ltd.

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
CEMDM501	Database Management System	20	20	60	1	2	100	

Course Objectives: The course aims to	
1	Learn and practice data modelling using the entity-relationship and developing database designs.
2	Implement the use of Structured Query Language (SQL) and learn SQL syntax.
3	Illustrate the needs of database processing and learn techniques for controlling the consequences of concurrent data access
4	Analyse the concept of database security and privacy
Course Outcomes: Learners will be able to	
1	Describe the fundamentals of database systems
2	Implement the different data models and design issues in database.
3	Design ER diagram, relational schemas, apply concepts of normalization to relational database design.
4	Analyse the basics model of relational Algebra, calculus.
5	Experiment views, triggers and querying the database using SQL.
6	Implement transaction management, concurrency control. database security and privacy

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Databases** Introduction to databases, History of database system, Benefits of Database system over traditional file system, relational databases, three tier database architecture, Data independence	4	CO1
02	**Data Models** The importance of data models, Introduction to various data models (hierarchical, Network, Relational, Entity relationship and object model), Basic building	3	CO2

	blocks, Business rules, Degrees of data abstraction		
03	**Database Design, ER-Diagram and Unified Modelling Language** Database design and ER Model: overview, ER-Model and its Constraints, ER-Diagrams, ERD Issues, weak entity sets Codd's rules, Relational Schemas, Introduction to UML Relational database model: Logical view of data, keys, integrity rules. Relational Database design: features of good relational database design, atomic domain	10	**CO3**
04	**Relational Algebra and Calculus** Relational algebra: Introduction, Selection and projection, set operations, renaming, Joins, Division, syntax, semantics. Operators, grouping and ungrouping, relational comparison. Calculus: Tuple relational calculus, Domain relational Calculus, calculus vs algebra, computational capabilities. Normalization methods : 1NF, 2NF, 3NF, BCNF, 4NF, 5NF	10	**CO4**
05	**Constraints, Views and SQL** What is constraints, types of constrains, Integrity constraints, SQL: data definition, aggregate function, Null Values, nested sub queries, Joined relations. Triggers. Views: Introduction to views, data independence, security, updates on views, comparison between tables and views SQL Tools : MySQL, ORACLE 10G, POSTGRESQL	10	**CO5**
06	**Transaction management and Concurrency control** Transaction management: ACID properties, serializability and concurrency control, Lock based concurrency control (2PL, Deadlocks), Time stamping methods, optimistic methods, database recovery management. Database Security and privacy: Issues, Access Control based on grant and revoke privileges	5	**CO6**
	Total	**42**	

Text Books:

1. Silberschatz, H Korth, S Sudarshan, "Database System and Concepts‖", Fifth Edition McGraw-Hill
2. Rob, Coronel, "Database Systems", Seventh Edition, Cengage Learning.
3. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database System‖", Seventh Edition, Person.
4. G. K. Gupta, "Database Management Systems‖", McGraw – Hill.

References:

1. Peter Rob and Carlos Coronel, "Database Systems Design, Implementation and Management", Thomson Learning, 5th Edition.
2. P.S. Deshpande, "SQL and PL/SQL for Oracle 11g, Black Book", Dreamtech Press
3. Mark L. Gillenson, Paulraj Ponniah, "Introduction to Database Management", Wiley
4. Raghu Ramkrishnan and Johannes Gehrke, "Database Management Systems", TMH
5. Debabrata Sahoo "Database Management Systems‖ Tata McGraw Hill, Schaum
6. https://www.w3schools.in/dbms/

7. https://www.tutorialspoint.com/dbms/index.htm
8. https://www.studytonight.com/dbms/

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2*+2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					2
ETVSEC501	Computational Lab	-	50	25	-	-	75	

*Two hours as e-learning for full class

Course Objectives: The course aims to	
1	Bridge the gap between academic learning and industry skill requirements.
2	Encourage students to complete recognized online certification courses.
3	Provide hands-on exposure in emerging technologies
4	Promote independent learning, portfolio building, and employability skills.
Course Outcomes: Learners will be able to	
1	Identify and pursue relevant industry skills through online learning platforms.
2	Demonstrate practical understanding of emerging technology.
3	Enhance skills through online certifications.
4	Design interdisciplinary project
5	Develop additional skills required to Integrate multiple technologies in a project.
6	Evaluate emerging technology scope for real time applications

Learners should select any course from MKCL/ NPTEL/ SWAYAM/ MOOCS/ Infosys Springboard/ Edunet/ Coursera, etc. #
Duration of Course **:** Minimum **25 Hours**
Few suggested **certification courses** are: Network Security, IoT, Robotics, Cyber Security Essentials, SQL Mastery, 3D Modelling, Drone Technology, Embedded System, Digital marketing, Digital forensic, Chip design, Oceanography, Electric Vehicle, Data Analysis, AI , ML Learning Tools and Techniques, Any high-level programming language, etc. # Any other relevant topics in discussion with the concerned faculty.

Continuous Internal Evaluation (50 Marks)

Contents	Evaluation for Student	
	Doing Online Certification	**NOT doing Course**

Lab Performance and regularity	Not Applicable	30 Marks
Presentation, regularity and Report	10 Marks	Not Applicable
Course Certificate	20 Marks	Not Applicable
In Semester Exam	20 Marks	20 Marks
Total	**50 Marks**	**50 Marks**

Students who will **not enrolled for online certification course** have to complete the lab experiments from the suggested list during lab hours.

Sr. No.	Suggested List of Experiments
01	Introduction to Network Security Tools
02	Encryption and Decryption (Symmetric & Asymmetric)
03	Secure Shell (SSH) and Secure Copy (SCP)
04	Virtual Private Network (VPN) Setup
05	Password Cracking (using John the Ripper)
06	Firewall Configuration (using iptables or ufw)
07	Intrusion Detection (with Snort)
08	Packet Sniffing and Analysis using Wireshark
09	Web Application Vulnerability Scanning (with OWASP ZAP)
10	Setting up a Honeypot (Kippo/Dionaea)

At the end of the Semester, Learner must submit a file containing their Lab performances or Online Course Certificate of successful completion.

Oral & Practical Exam (25 Marks)

An Oral & Practical exam will be held based on the Online Certification Course Content or Lab Experiments mentioned above.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ETPCL501	Discrete Time Signal Processing Lab	-	25	25	-	-	50	

Prerequisite:	
Course Objectives: The course aims to	
1	Use the basic discrete time signal processing operations.
2	Apply the concept of DFT and FFT.
3	Implement and design FIR Filters and IIR filters.
4	Implement applications related to the field of biomedical signal processing and audio signal processing.
Course Outcomes: Learners will be able to	
1	Apply the basic discrete time signal processing operations such as Linear Convolution, Circular Convolution, etc. and interpret the results.
2	Evaluate Discrete-time Fourier transform, fast Fourier transform and apply in system analysis.
3	Implement and design IIR Filter for given specifications.
4	Implement and design FIR Filter for given specifications.
5	Apply and interpret frequency analysis of different discrete time sequences and systems.
6	Implement and analyse applications related to the field of biomedical signal processing and audio signal processing.

Suggested List of Experiments

Sr. No	Title of Experiment	COs
1.	To evaluate DFT / IDFT of given DT signal	**CO2**
2.	Perform basic discrete time signal processing operations of Circular Convolution on two finite length sequences and interpret the results.	**CO1**
3.	To find frequency response of a given system (transfer function/ difference equation)	**CO5**
4.	Implementation of FFT of given sequence	**CO2**

5.	Implementation and design of LP IIR filter for a given sequence	**CO3**
6.	Implementation and realization of HP IIR filter for a given sequence	**CO3**
7.	Implementation and design of LP FIR filter for a given sequence	**CO4**
8.	Implementation and realization of HP FIR filter for a given sequence	**CO4**
9.	Verify the Decimation of a given sequence.	**CO6**
10.	Analysis of ECG/EEG signals.	**CO6**

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Oral & Practical Exam (25 Marks)

An Oral & Practical exam will be held based on the entire syllabus.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ETPCL502	Digital VLSI Lab	-	25	25	-	-	50	

Prerequisite: Digital system design	
Course Objectives: The course aims to	
1	Learn circuit simulation tools like Microwind, Verilog (Vivado) etc.
2	Design, implement and verify CMOS circuits using Microwind
3	Understand Lambda based design rules for NMOS and MOS circuits
4	Design, implement and verify Digital circuits using Verilog
Course Outcomes: Learners will be able to	
1	Draw layout of given CMOS circuit.
2	Verify different design rules from layout.
3	Evaluate performance of given CMOS circuits.
4	Write Verilog code for given combinational and sequential CMOS circuits.
5	Understand and correct the error in Verilog coding, test bench and simulation
6	Design, simulate, and verify CMOS circuit for given specifications.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	To design and simulate the layout of NMOS Inverter	CO1,CO2,CO3
02	To design and simulate the layout of CMOS Inverter	CO1,CO2,CO3
03	To design and simulate the layout of 2 input CMOS NAND gate	CO1,CO2,CO3
04	To design and simulate the layout of 2 input CMOS NOR gate	CO1,CO2,CO3

05	To design and simulate the layout of the Boolean function F= /(A.B + C) using CMOS.	CO1,CO2,CO3, CO6
06	To design and Simulate Pseduo-NMOS NAND logic	CO1,CO2,CO3
07	To design and Simulate Clocked CMOS Inverter	CO1,CO2,CO3
08	Write and simulate Verilog code for Multiple Gates	CO4,CO5,CO6
09	Write and simulate Verilog code for Multiplexer	CO4,CO5,CO6
10	Write and simulate Verilog code for Adder	CO4,CO5,CO6

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Oral & Practical Exam (25 Marks)

An Oral & Practical exam will be held based on entire syllabus.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ETPECL5011	Computer Communication Networks Lab	-	25	25	-	-	50	

Prerequisite: Elements of Telecommunication Engineering	
Course Objectives: The course aims to	
1	Learn the fundamentals of data communication
2	Analyze layered network architectures such as the OSI and TCP/IP models.
3	Understand flow control, error control, and congestion control mechanisms.
4	Explore protocols, technologies and network addressing schemes
Course Outcomes: Learners will be able to	
1	Demonstrate understanding of core networking concepts like switching, routing, addressing, and protocols.
2	Simulate or implement networking protocols using tools like Cisco Packet Tracer, Wireshark, etc
3	Design and analyze simple network topologies using routers, switches, and hosts.
4	Simulate computer networks and analyze the simulation results.
5	Troubleshoot basic network issues using standard commands and diagnostic tools.
6	Develop necessary skill to become computer network engineer.

Sr. No.	List of Experiments	CO Mapping
01	To study basic networking commands. (Linux/Windows)	CO1
02	To configure hybrid network using Cisco Packet Tracer	CO1
03	To configure static routes in a network using Cisco Packet Tracer.	CO2
04	To configure a network with Distance Vector Routing Protocol-RIP using Cisco Packet Tracer	CO2,CO5

05	To configure a network with Path Vector Routing Protocol- BGP using Cisco Packet Tracer	CO2,CO5
06	To configure a network with Link state Routing Protocol- OSPF using Cisco Packet Tracer	CO2,CO3
07	To perform subnetting using Cisco Packet Tracer	CO2,CO5
08	To configure DNS, DHCP, TELNET using Cisco Packet Tracer	CO2,CO5,CO6
09	To configure FTP, SMTP server using Cisco Packet Tracer	CO2,CO5,CO6
10	To configure a network with Hybrid Routing Protocol	CO2,CO5,CO6
11	To Simulate and study the implementation of TCP/IP stack using wireshark.	CO2,CO5,CO6
12	To configure wireless network using Cisco Packet Tracer	CO6

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Oral & Practical Exam (25 Marks)

An Oral & Practical exam will be held based on entire syllabus.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ETPECL5012	IT Infra & Security Lab	--	25	25	--	--	50	

Prerequisite: Principles of Communication	
Course Objectives: The course aims to	
1	Explain the basics of IT Infrastructure and its Management
2	Develop underlying principles of infrastructure security
3	Name the software vulnerabilities and attacks
4	Explain the protection mechanisms for operating systems and database security
Course Outcomes: Learners will be able to	
1	Discuss and evaluate the protection mechanisms for operating systems and database security.
2	Show the concept of IP addressing and Networking commands
3	Measure the concepts of attacks and protection mechanisms
4	Outline the software vulnerabilities and attacks on databases and operating systems
5	Describe the need for security protocols in the context of wireless communication
6	Classify the different attacks on Open Web Applications and Web services

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	To understand network architecture and implement different networking commands.	CO1
02	To learn IP addressing schemes and subnetting using simulation tools.	CO1
03	Study of Access Control Mechanisms (DAC, MAC, RBAC) Show and compare access control policies in operating systems.	CO2
04	To demonstrate password-based and token-based authentication methods.	CO2
05	To identify and simulate common web vulnerabilities in a controlled environment.	CO3

06	To study malware behavior safely using sandbox or simulation tools.	CO3
07	To configure and test system-level firewall rules for security.	CO4
08	To apply access control and privileges in database systems.	CO4
09	To understand wireless encryption methods and their vulnerabilities.	CO5
10	To understand web-based security threats and protection mechanisms.	CO6
11	To simulate VPN tunneling and encryption for secure data transmission.	CO5
12	To implement basic encryption and decryption using programming language.	CO2

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Oral & Practical Exam (25 Marks)

An Oral & Practical exam will be held based on entire syllabus.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ETPECL5013	Radar Engineering Lab	-	25	25	-	-	50	

Prerequisite:	
Course Objectives: The course aims to	
1	Understanding of the fundamental principles of radar, including the radar range equation
2	Understanding of the Doppler effect, and target characteristics.
3	To provide hands-on experience and practical application of the theoretical concepts of radar systems.
4	Provide operational characteristics of different radar systems.
Course Outcomes: Learners will be able to	
1	Use simulation tools to design and test radar components and subsystems
2	Verify Doppler effect and target characteristics.
3	Hands-on experience of the theoretical concepts of radar systems.
4	Understand operational characteristics of continuous Wave (CW) radar
5	Understand operational characteristics of Frequency Modulated Continuous Wave (FM-CW) radar.
6	Understand operational characteristics of Moving Target Indication (MTI) radar, Pulse Doppler radar

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	To find the radial velocity of a moving target using Doppler effect.	CO2
02	To find the distance of moving target/stationary target from the radar.	CO2
03	To find out the time period if simple pendulum using Doppler radar	CO2
04	To find out rpm of a fan at some distance D from the radar.	CO3

05	To find out the frequency of a buzzer in presence of various clutter noises.	CO4
06	Simulation to find the radial velocity of a moving target using Doppler effect.	CO2,CO3
07	Simulation to find the distance of moving target/stationary target from the radar.	CO6,CO3
08	Simulation to find out the time period if simple pendulum using Doppler radar	CO6
09	Simulation to find out rpm of a fan at some distance D from the radar.	CO3
10	Simulation to find out the frequency of a buzzer in presence of various clutter noises.	CO4,CO3

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Oral & Practical Exam (25 Marks)

An Oral & Practical exam will be held based on entire syllabus.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
CEMDML501	Database Management System Lab	-	25	-	-	-	25	

Course Objectives: The course aims to	
1	Explore design and develop of relational model 2 3
2	Present SQL and procedural interfaces to SQL comprehensively
3	Introduce the concepts of transactions and transaction processing
4	Design of different queries.
Course Outcomes: Learners will be able to	
1	Design ER /EER diagram and convert to relational model for the real world application.
2	Apply DDL, DML, DCL and TCL commands
3	Apply simple and complex queries
4	Explore PL / SQL Constructs.
5	Learn simple and complex queries
6	Demonstrate the concept of Views, Trigger

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
1	Identify the case study and detail statement of problem. Design an Entity-Relationship (ER) / Extended Entity-Relationship (EER) Model	CO1
2	Mapping ER/EER to Relational schema model.	CO1
3	Create a database using Data Definition Language (DDL) and apply integrity constraints for the specified System	CO2
4	Apply DML Commands for the specified system	CO2
5	Perform Simple queries, string manipulation operations and aggregate	CO3

	functions.	
6	Implement various Join operations.	CO4
7	Perform Nested and Complex queries	CO5
8	Perform DCL and TCL commands	CO2
9	Implement procedure and functions	CO5
10	Implementation of Views and Triggers	CO6

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Oral & Practical Exam (25 Marks)

An Oral & Practical exam will be held based on entire syllabus.

Department of Electronics & Telecommunication Engineering
Third Year Engineering Curriculum: Semester VI

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ETPCC601	Electromagnetic and Antenna	20	20	60	1	2	100	

Prerequisite: *Vector Calculus Fundamental concepts of electricity and magnetism*	
Course Objectives: The course aims to,	
1	Understand fundamental of electromagnetic theory
2	Develop understanding of electric and magnetic field and their interrelationship
3	Analyse Antenna array and radiation pattern
4	understand radiation mechanism and theorem
Course Outcomes: Learners will be able to	
1	Describe electromagnetic fields including static and dynamic in terms of Maxwell's equations.
2	Apply Maxwell's equation to solve various electromagnetic phenomenon such as electromagnetic wave propagation in different medium, power in EM wave.
3	Define various antenna parameters, analyse radiation patterns of antennas and evaluate antennas for given specifications.
4	Implement different types of the antenna structures such as Antenna arrays, Microstrip antenna and reflector antenna etc.
5	Design microstrip antenna with different shapes
6	Understand and differentiate radio wave propagation

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Static fields** Charge, Coulomb's law, Charge configurations, Electric field intensity, Electric flux density, Gauss's law and applications, Current density, and Continuity equation Scalar Electric Potential, Potential gradient, Laplace's and Poison's equations Biot Savart Law, Ampere Circuit law, Gauss's law for magnetic field, Vector magnetic potential	7	CO1
02	**Electromagnetic Field and Maxwell's Equations** Faraday's Law, Displacement current density, Maxwell's equation for time varying field, Boundary conditions. EM wave propagation through lossy, perfect dielectric and conducting medium. Power in EM Wave: Poynting theorem and Poynting vector .	8	CO2
03	**Basic of Antennas** Basic concepts: Radiation mechanism, Near field and far field radiation, retarded potential Antenna Parameters: Isotropic antenna, Radiation pattern, radiation intensity, Beamwidth, directivity, Gain, beam efficiency, bandwidth, polarization, Input impedance, Antenna efficiency, Radiation resistance, Loss resistance, aperture concept, FRISS transmission formula Wire Elements: Infinitesimal dipole, Wire dipole, Monopole antennas: radiation field derivations and related parameters, Introduction to loop antenna	9	CO3
04	**Antenna Arrays** Linear arrays of two isotropic point sources, linear arrays of N elements, Principle of pattern multiplication Introduction to Planner and circular arrays. Introduction to array synthesis using Binomial array	7	CO4
05	**Types of antennas** Yagi-uda antenna, Broadband antenna like Helical and Log Periodic antenna Horn Antennas: E-Plane Sectoral Horn, H-Plane Sectoral Horn, Pyramidal Horn and Conical Horn Reflector Antennas: Plane Reflectors, Corner Reflectors and Parabolic Reflector Patch Antenna: Microstrip antenna, Feeding Techniques, Introduction to design of Microstrip antenna (Rectangular and circular patch)	7	CO5
06	**Electromagnetic Wave Propagation** Ground Wave Propagation, Sky Wave Propagation and Space Wave Propagation.	4	CO6
	Total	42	

Text Books:

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

References:

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

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ETPCC602	Image Processing and Machine Vision	20	20	60	1	2	100	

Prerequisite: Signal and System, Discrete time signal processing	
Course Objectives: The course aims to	
1	Learn implementing basic theoretical concepts in Image Processing and Machine Vision using relevant software.
2	Enhance the exposure to students to object recognition/ classification techniques in Machine Vision.
3	Illustrate the practical aspects of Image Processing and Machine Vision through an .
4	Analyse the application of image processing
Course Outcomes: Learners will be able to	
1	Learn fundamentals of image processing and machine vision
2	Enhance the quality of image using spatial and frequency domain techniques for image enhancement
3	Implement image morphology and restoration techniques
4	Analyse 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

Module	Detailed Contents	Hrs.	CO Mapping
01	**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	**CO1**

02	**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	**CO2**
03	**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	7	**CO3**
04	**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 reflectance, Basic global thresholding Region Based segmentation: Region Growing, Region Splitting and merging	9	**CO4**
05	**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	6	**CO5**
06	**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	**CO6**
	Total	**42**	

Text Books:

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

References:

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-IEEE Press, 2010
5. nptel.ac.in/courses/117105135

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ETPEC6011	Wireless Networks	20	20	60	1	2	100	

Prerequisite: Computer Communication Networks Mobile Communication System	
Course Objectives: The course aims to	
1	Analyze the fundamental architecture, design issues and standards of wireless networks.
2	Compare Personal Area Network (PAN) technologies such as ZigBee, Bluetooth, UWB, NFC and 6LoWPAN and Classify different LAN topologies, technologies and ad hoc networks.
3	Classify network protocols, ad hoc vehicle networks, Wireless MANs and Understand planning and design of GSM and CDMA system in Wireless WANs.
4	Apply Wireless sensor networks concepts to develop an IoT applications
Course Outcomes: Learners will be able to	
1	Explain fundamental architecture, design issues and standards of wireless networks.
2	Compare different types of Personal Area Network (PAN) technologies such as ZigBee, Bluetooth, UWB, NFC and 6LoWPAN.
3	Analyze different LAN topologies and technologies and ad hoc networks.
4	Compare various types of network protocols, ad hoc vehicle networks and Wireless MANs
5	Evaluate the planning and design of performance of GSM and CDMA system in Wireless WANs.
6	Understand the basic network architecture of Wireless sensor networks concepts to develop an IoT applications.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Overview of wireless networks** Wireless Networks**:** Architecture, Classifications, Switching technology, Communication Problems, Reference Models. Networking issues and Networking Standard. Wireless Body Area Networks: Properties, Network Architecture, Network components and Applications **Self-learning:** Merits and demerits of wireless networks	6	**CO1**
02	**Wireless Personal Area Networks** WPAN: Bluetooth (802.15.1): Radio Specifications, Protocol Stack, Link Types, Security, Topologies, Applications. ZigBee (802.15.4): Radio Specifications, Components, Topologies, Protocol Stack, Applications. RFID: Radio Specifications, Architecture, Types and applications. Near Field Communication & UWB (802.15.3 a): Introduction and working. 6LoWPAN: Features, Architecture, protocol stack and applications **Self-learning**: Protocol development for wireless technologies	**8**	**CO2**
03	**Wireless Local Area Network & Wireless Adhoc Networks** Wireless Local Area Network: Equipment, Topologies, Technologies, Applications, Main features of IEEE802.11a,b, i and n, Protocol, Architecture of WLAN, Wireless Adhoc Networks: Features, advantages & Applications, Mobile Adhoc Networks: Network Architecture, MAC Protocol.	**7**	**CO3**
04	**Wireless Metropolitan & Vehicular Adhoc Networks** WMAN (IEEE802.16)**:**Introduction, WMAN Network Architecture, Network Protocols, Broadband Wireless Networks, Applications, Vehicular Adhoc Networks (VANETs)**:** Characteristics, Protocols & Applications .	**7**	**CO4**
05	**Wireless Wide Area Networks** Planning and design of Wireless Networks, Radio design for a cellular Network, receiver sensitivity, and link budget for GSM, CDMA, and LTE.	**7**	**CO5**
06	**Advanced Technologies of Wireless Networks** Wireless Sensor Networks: Network Architecture, Design Considerations, Network Protocol Stack, and Applications, Internet of Things: IoT Conceptual Frame work, Architecture, Technology & Examples. M2M Communication, Introduction to Artificial Intelligence.	**7**	**CO6**

	Self learning: Role of AI in wireless network design		
	Total	**42**	

Text Books :

1. Vijay K. Garg, "Wireless Communication and Networking", Morgan -Kaufmann in Networking—Elsevier
2. Kazem Sohraby, Daniel Minoli, and Taieb Znati, "Wireless Sensor Networks: Technology, Protocols, and Applications", Wiley Student Edition
3. Dr SunilkumarS. Manvi, Mahabaleshwar S. Kakkasageri, "Wireless and Mobile Networks Concepts and Protocol"Wiley India Pvt Ltd
4. Raj Kamal, "Internet of Things Architecture & Design Principles" Mcgraw Hill.

References:

1. R. Vannithamby and S. Talwar, Towards 5G: Applications, Requirements and Candidate Technologies., John Willey & Sons, West Sussex, 2017.
2. Manish, M., Devendra, G., Pattanayak, P., Ha, N., 5G and Beyond Wireless Systems PHY Layer Perspective, Series in Wireless Technology Springer, 2021

NPTL Swayam Course :

1. https://nptel.ac.in/courses/106105160
   http://digimat.in/nptel/courses/video/108106192/L02.html

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ETPEC6012	Natural Language Processing	20	20	60	1	2	100	

Prerequisite: *Vector Calculus Fundamental concepts of electricity and magnetism*	
Course Objectives: The course aims to,	
1	Understand natural language processing and to learn how to apply basic algorithms in this field.
2	Acquainted with the basic concepts and algorithm
3	Familiar with main language levels: morphology, syntax, semantics, and pragmatics.
4	Design and implement applications based on natural language processing
Course Outcomes: Learners will be able to	
1	Understanding the field of natural language processing
2	Describe mathematical and linguistic preliminaries necessary for various processes in NLP
3	Design, implement and test algorithms for NLP problems
4	Perform Word-Level, Syntax-Level and Semantic-Level Analysis
5	Develop basic understanding of Pragmatics in NLP
6	Apply NLP techniques to design real world NLP applications

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Natural Language Processing** The need of NLP. Generic NLP system, Levels of NLP Stages in building a Natural Language Processing System. Challenges and ambiguities in NLP Design	7	CO1
02	**Mathematical and Linguistic Preliminaries** Probability Theory, Conditional Probability and Independence, Bayes Rule, Random Variables, Probability Distributions, Statistics, Counting, Frequency, Mean and Variance English Grammar, Parts of Speech, Phrase Structures	9	CO2
03	**Word Level Analysis** Tokenization, Segmentation, Lemmatization, Edit Distance, Collocations, Porter Stemmer, N-gram Language Model, Morphological Analysis, Derivational and Reflectional Morphology	8	CO3
04	**Syntax Analysis** Tag set for English, Penn Tree bank, Introduction to Parts of Speech Tagging (POST) , Markov Processes, Hidden Markov Models (HMM) Parts of Speech Tagging using Hidden Markov Models, Viterbi Algorithm	7	CO4
05	**Semantic Analysis** Lexical Semantics, ambiguous words, word senses, Relations between senses: synonym, antonym, reversives, hyponym, hypernym, meronym, structured polysemy, metonymy, zeugma Introduction to WordNet, gloss, synset, sense relations in WordNet. Cosine distance between documents. Word sense disambiguation.	7	CO5
06	**Pragmatics and applications of NLP** Applications of NLP: Categorization, Summarization, Sentiment Analysis, Named Entity. Recognition, Machine Translation, Information Retrieval, Question Answer System	4	CO6
	Total	42	

Text Books:

1. Daniel Jurafsky, James H. Martin, Speech and Language Processing‖ Second Edition, Prentice Hall.
2. Christopher D. Manning and Hinrich Schutze, Foundations of Statistical Natural Language Processing, MIT Press.

References:

1. Steven Bird, Ewan Klein, Natural Language Processing with Python, O'Reilly
2. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor), The Handbook of Computational

Linguistics and Natural Language Processing

NPTEL / Swayam Course:

1. Course: Natural Language Processing By Prof. Pawan Goyal, IIT Kharagpur
   https://onlinecourses.nptel.ac.in/noc21_cs102/preview
2. Course: Applied Natural Language Processing By Prof. Ramaseshan R, CMI
   https://onlinecourses.nptel.ac.in/noc20_cs87/preview

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ETPEC6013	**Satellite communication**	20	20	60	1	2	100	

1)Prerequisite:Analog and digital communication	
Course Objectives: The course aims to	
1	Discuss the basics of satellite communications and different satellite communication orbits.
2	Provide an in-depth understanding of satellite communication system operation, launching techniques, satellite link design and earth station technology.
3	Explain the tools necessary for the calculation of basic parameters in a satellite communication system.
4	Review the state of the art in new research areas such as speech and video coding, satellite networking and satellite personal communications, mobile satellite communication, Laser satellite.
Course Outcomes: Learners will be able to	
1	Explain basics of satellite communication, space segment and earth segment
2	Discuss different satellite orbits and orbital parameters
3	Design concept of earth station and antenna
4	Analyze link budget of satellite signal for proper communication
5	Compare multiple access technique
6	Review various applications of satellite communications

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction** **Overview of Satellite Systems, Orbits and Launching:** An overview of space and satellite, Frequency allocation for satellite communication, Polar orbiting satellites, Kepler's First, second and third law, orbital elements, apogee, perigee heights, orbital perturbations, effects of a non-spherical earth, atmospheric drag. Wave Propagation & Polarization, Atmospheric Losses, Ionospheric Effects, Rain Attenuation, Other impairments, Antenna Polarization, Polarization of Satellite signals, Cross polarization discrimination, Ionospheric depolarization, Rain depolarization, Ice depolarization. Sub-satellite Point, predicting satellite position, antenna look angels, polar mount antenna, limits of visibility, near geostationary orbits, earth eclipse of satellite, sun transit outage. Selection of launching site, launch window, zero and non-zero degree latitude launching, sea launch,launch vehicles:satellite launch vehicle (SLV), augmented satellite launch vehicle (ASLV), polar SLV, geostationary satellite launch vehicle (GSLV)	8	CO1
02	**Space Segment:** Satellite configuration, Transponder sub-system, Antenna sub-system, AOC Sub-system, TT&C Sub-system, power sub-system, Thermal sub-system, reliability and quality Assurance.	6	CO2
03	**Earth station:** Design consideration General configuration- Block diagram, Receive only type earth, transmit-receive type earth station, Antenna system, Feed system, Tracking system, LNA, HPA.	6	CO3
04	**Satellite Links:** Isotropic radiated power, transmission losses, free-space transmission feeder losses, antenna misalignment losses, fixed atmospheric and ionospheric losses, link power budget. System noise, antenna noise, amplifier noise temperature, amplifiers in cascade, noise factor, noise temperature of absorptive networks,overall system noise temperature, carrier to noise ratio. Uplink: Saturation flux density, input back off, earth station HPA, Downlink: Output back off, satellite TWTA output.	8	CO4
05	**The Space Segment Access and Utilization:** Space segment access methods, pre-assigned FDMA, demand assigned FDMA, SPADE system, bandwidth-limited and power limited TWT amplifier operation. TDMA: Reference Burst; Preamble and Postamble, carrier recovery, network synchronization, unique word detection, traffic date, frame efficiency, channel capacity, preassigned TDMA, demand assigned TDMA, satellite switched TDMA.CDMA	8	CO5
06	**Satellite Applications:**	06	CO6

	VSATsystems:Advantages,configurations,frequency bands, elements, Mobile satellite communication:NMARSAT,LMSS.Mobile satellite systems with non GEO satellites. Modern development and future trends.		
	TOTAL	**42**	

Text Books:

1. Dennis Roddy, "Satellite Communications‖", 4th Ed., Mc. Graw-Hill International Ed. 2009.
2. M. Richharia, "Satellite Communication Systems Design Principles‖", Macmillan Press Ltd. Second Edition 2003.
3. R. N. Mutangi, "Satellite Communication‖", Oxford university press, 2016.
4. Gerard Maral and Michel Bousquet, "Satellite Communication Systems‖", 4th Edition Wiley Publication

References:

1. Gerard Maral, —VSAT Networks‖, John Willy & Sons
2. Timothy Pratt, Charles Bostian, and Jeremy Allmuti, —Satellite Communications‖, John Willy & Sons (Asia) Pvt. Ltd. 2004
3. Wilbur L. Pritchard, Henri G. Suyderehoud, and Robert A. Nelson," Satellite Communication systems Engineering‖", Pearson Publication

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ETPEC6021	5G Technology	20	20	60	1	2	100	

Prerequisite: Digital Communication	
Course Objectives: The course aims to	
1	Learn the basics of 5G technology and beyond wireless communication
2	Study 5G network architecture, Heterogeneous Network, and concept of Small cells
3	Understand the key technologies and enablers of 5G and beyond communication systems.
4	Learn 5G technologies like massive MIMO, mmWave, Cognitive Radio etc.
Course Outcomes: Students should be able to	
1	Understand the fundamentals of 5G technology, its features, requirements, modulation techniques, physical layer, and protocol stack.
2	Analyze the architecture of 5G networks including Cloud RAN, heterogeneous networks, radio resource management, mobility management, and small cell deployment techniques.
3	Explain millimeter wave communication transceivers, propagation characteristics, beamforming, channel modeling, channel estimation, merits, demerits and applications.
4	Apply and analyse the fundamental 5G service categories and their real-world applications in next-generation communication systems.
5	Apply cognitive radio concepts for spectrum optimization, interference mitigation in heterogeneous 5G wireless networks, cognitive radio enabled operations, and compressive sensing.
6	Evaluate modern trends and applications in 5G including 5G NR, Open RAN, carrier aggregation, AR/VR, and tactile internet applications.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to 5G** Introduction to 5G technology, features, requirements, and 5G services. Digital Modulations: OFDM, Massive MIMO with beamforming, Physical layer, Protocol stack.	6	CO1
02	**5G Architecture**		

	5G Network Architecture, Cloud RAN(C-RAN), Definitions of Heterogeneous Networks, Radio Resource and Interference Management for Heterogeneous Networks, mobility management and handover. Small cell deployments: different types, Deployment scenarios, Game theory and learning techniques for self-organization in small cell networks, 3GPP RAN standards for small cell	**8**	**CO2**
03	**MmWave Communication** mmWave: Millimeter bands, mmWave-MIMO challenges, channel modelling, channel estimation and Beam-forming. Types of transceivers, Merits and Demerits, Applications	**7**	**CO3**
04	**5G Use Cases** Enhanced Mobile Broadband (eMBB), Ultra-Reliable Low Latency Communication (URLLC), Massive Machine Type Communication (mMTC), Industrial IoT, Smart Cities, Smart Health Care, and Autonomous Vehicles.	**7**	**CO4**
05	**Cognitive Radio for 5G Wireless Networks** Introduction, Overview of Cognitive Radio Technology in 5G wireless, Spectrum Optimisation using Cognitive Radio, Cognitive Radios to Mitigate Interference in Macro/femto Heterogeneous Networks, Cognitive Radio enabled Operations, Intra-tier Interference mitigation, Compressive sensing	**8**	**CO5**
06	**Trends in 5G** Modern trends and applications in 5G, 5G NR, Open RAN, Carrier Aggregation, AR/VR, tactile internet applications	**6**	**CO6**
	Total	**42**	

Text Books:

1. Principles of Modern Wireless communication systems by Aditya k Jagannathan
2. Robert W. Heath, Robert C. Daniel, James N. Theodore S. Rappaport, Murdock, "Millimeter Wave Wireless Communication", Prentice Hall, 2014.

Reference Books:

1. R. Vannithamby and S. Talwar, Towards 5G: Applications, Requirements and Candidate Technologies, John Willey & Sons, West Sussex, 2017.
2. Manish, M., Devendra, G., Pattanayak, P., Ha, N., 5G and Beyond Wireless Systems PHY Layer Perspective, Series in Wireless Technology Springer, 2021
3. Alagan Anpalagan, Mehdi Bennis, Rath Vannithamby, Design and deployment of small cell networks, Cambridge university press, 2015.
4. T. S. Rappaport, R. W. Heath Jr., R. C. Daniels, and J. M. Murdock, Millimeter Wave Wireless Communication., Pearson Education, 2015.
5. M. Vaezi, Z. Ding, and H. V. Poor, Multiple Access techniques for 5G Wireless Networks and Beyond., Springer Nature, Switzerland, 2019

NPTL Swayam Course:

https://onlinecourses.nptel.ac.in/e-learning/preview/noc24_ee152

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ETPEC6022	Machine Learning	20	20	60	1	2	100	

Prerequisite:	
Course Objectives: The course aims to	
1	Recall the basic concepts and techniques of Machine Learning.
2	Discuss various supervised and unsupervised algorithms
3	Apply various ensemble techniques for combining ML models.
4	Demonstrate dimensionality reduction techniques.
Course Outcomes: Learners will be able to	
1	Describe the fundamental knowledge of developing machine learning models.
2	Apply and evaluate an appropriate machine learning model for the given application.
3	Demonstrate ensemble techniques to combine predictions from different models.
4	Apply classification model for given application.
5	Apply clustering algorithms for different types of applications and analyse their results.
6	Demonstrate the dimensionality reduction techniques.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Machine Learning** Machine Learning, Types of Machine Learning, Application of Machine Learning, Steps in developing a Machine Learning Application. Training Error, Generalization error, Overfitting, Underfitting, Bias-Variance trade-off.	8	CO1
02	**Learning with Regression and Trees** Learning with Regression: Linear Regression, Multivariate Linear Regression, Logistic Regression. Learning with Trees: Decision Trees, Constructing Decision Trees using Gini Index (Regression), Classification and Regression Trees (CART) Performance Metrics: Confusion Matrix, [Kappa Statistics], Sensitivity, Specificity, Precision, Recall, F-measure, ROC curve.	8	CO2

03	**Ensemble Learning** Understanding Ensembles, K-fold cross validation, Boosting, Stumping, XGBoost Bagging, Subagging, Random Forest, Comparison with Boosting.	8	CO3
04	**Learning with Classification** Support Vector Machine Constrained Optimization, Optimal decision boundary, Margins and support vectors, SVM as constrained optimization problem, SVM for linear and nonlinear classification, Basics of Kernel trick. Support Vector Regression, Multiclass Classification.	7	CO4
05	**Learning with Clustering** Introduction to clustering with overview of distance metrics and major clustering approaches. Graph Based Clustering: Clustering with minimal spanning tree, Model based Clustering: Expectation Maximization Algorithm.	6	CO5
06	**Dimensionality Reduction** Dimensionality Reduction Techniques, Principal Component Analysis, Linear Discriminant Analysis, Singular Valued Decomposition.	5	CO6
	TOTAL Hrs.	42	

Text Books:

1. Peter Harrington,"Machine Learning n Action", DreamTech Press
2. Ethem Alpaydın, "Introduction to Machine Learning", MIT Press
3. Tom M. Mitchell, "Machine Learning", McGraw Hill
4. Stephen Marsland, "Machine Learning An Algorithmic Perspective‖", CRC Press

Reference Books

1. Han Kamber, "Data Mining Concepts and Techniques‖", Morgan Kaufmann Publishers
2. Margaret. H. Dunham, "Data Mining Introductory and Advanced Topics", Pearson Education
3. Kevin P. Murphy, "Machine Learning — A Probabilistic Perspective"
4. Samir Roy and Chakraborty, "Introduction to soft computing", Pearson Edition.
5. Richard Duda, Peter Hart, David G. Stork, "Pattern Classification", Second Edition, Wiley Publications.

Useful Digital Links

1. Data sets for Machine Learning algorithms: https://www.kaggle.com/datasets
2. Machine Learning repository- https://archive.ics.uci.edu/ml/index.php
3. Machine Learning from Coursera
4. https://towardsdatascience.com/machine-learning/home
5. https://onlinecourses.nptel.ac.in/noc21_cs85/preview

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks

3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)
End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ETPEC6023	Robotics	20	20	60	1	2	100	

Prerequisite: Basic Electronics Engineering & Mechanics	
Course Objectives: The course aims to	
1	Apply the basic principles of robotics
2	Understand basics of robotics, types, classification and methodology.
3	Introduce the Various Parts of Robots and Fields of Robotics.
4	Analyze applications of robotics, Planning and control in Robotics.
Course Outcomes: Learners will be able to	
1	Apply the basic principles of robotics
2	Illustrate basics of robotics, types, classification and methodology.
3	Understand the Various Parts of Robots and Fields of Robotics.
4	Implement different skills in understanding principles of robotics.
5	Develop skills in understanding industrial robotics.
6	Identifying opportunities for robotics to enhance productivity in manufacturing.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction of Robotics** Historical development of Robotics. Definitions of Industrial Robot & Types. Classification of Robots, Asimov's laws of robotics, Methodology of robotics.	7	CO1
02	**Principles of Robotics** Robot configurations, Robot Components., Robot Degrees of Freedom, Work volume and work envelope. Robot Joints and symbols, Robot Coordinates, Robot Reference Frames. Resolution, accuracy and precision of Robot, Work cell control	8	CO2
03	**Robotics in Inspection** Robots for Inspection: Robotic vision systems. Image representation, object recognition Categorization, depth measurement.	7	CO3
04	**Industrial Applications of Robotics** Introduction of processes like Coating, Deburring, cleaning, Die Casting, Molding. Material handling, Picking, Palletizing, Packaging, hospitals and patient care, sports and recreation Defense and surveillance industry, home automation. Mining industry.	7	CO4
05	**Planning and control in Robotics** Trajectory planning, position control, force control. Robot programming methods, hybrid control. Industrial and medical robotics: application in manufacturing processes	7	CO5

06	**Socio-economic aspects of Robotics** A robot-based manufacturing system. Robot cell design considerations and selection of robot.Robot Economics, Functional Safety in Robotic Application	6	CO6
	Total	42	

Text Books:

1. M.P. Groover, "Automation, Production Systems & Computer Integrated Manufacturing", PHI, 3rd Edition, 2018.
2. M.P. Groover, M. Naegel, "Industrial Robotics, Technology, Programming & Applications", TMH, 2nd Edition, 2016.

References: Books

1. J.G. Keramas, "Robotics Technology Fundamentals", Thompson Learning, 2nd Edition, 2016.
2. J.J.Craig "Introduction to Robotics Mechanics & Control", Pearson Education, 3rd Edition, 2014.
3. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill Book, 2015.

Other Useful 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
4. NPTEL link : https://nptel.ac.in/courses/107106090

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
CEMDM601	Big Data Computing	20	20	60	1	2	100	

Prerequisite: Data base management system	
Course Objectives: The course aims to	
1	Describe an Overview of an exciting growing field of Big Data Analytics.
2	Discuss the tools required to manage and analyze big data like Hadoop, NoSQL, Map Reduce.
3	Apply the fundamental techniques in achieving big data analytics with scalability and streaming capability
4	Discuss the several types of big data like social media, web graphs and data streams.
Course Outcomes: Learners will be able to	
1	Describe the key issues in big data management and its associated applications in intelligent business and scientific computing
2	Outline fundamental enabling techniques and scalable algorithms like Hadoop, MapReduce and NoSQL in big data analytics.
3	Predict the business models and scientific computing paradigms, and apply software tools for big data analytics
4	Describe adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc
5	Develop applications for Big Data analysis using Hadoop and NoSQL etc.
6	Design and implement successful Recommendation engines for enterprises.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Big data Analytics** Introduction to Big Data, Big Data characteristics, Types of Big Data, Traditional vs. Big Data a business approach, Traditional vs. Big Data business approach, Big Data Challenges, Examples of Big Data in Real Life, Big Data Applications	2	CO1
02	**Hadoop** Introduction to Hadoop. Core Hadoop Components, Hadoop Ecosystem-Apache HBase, Hive, HCatalog, Pig, Mahout, Oozie, Zookeeper, Sqoop, Physical Architecture, Hadoop limitations.	6	CO2
	NoSQL		

03	Introduction to NoSQL, NoSQL business drivers, NoSQL database case studies. NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, Variations of NoSQL architectural patterns Using NoSQL to manage big data: What is a big data NoSQL solution? Understanding the types of big data problems; Analysing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; Four ways that NoSQL systems handle big data problems, Managing MongoDB database with CRUD operations	**7**	**CO3**
04	**Map Reduce** MapReduce and The New Software Stack: Distributed File Systems, Physical Organization of Compute Nodes, Large Scale File-System Organization. MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping with Node Failures Algorithms Using MapReduce: MapReduce Wordcount Program, Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations by MapReduce, Matrix Operations, Matrix Multiplication by MapReduce .	**6**	**CO4**
05	**Techniques in Big Data Analytics** Finding Similar Item: Nearest Neighbour Search, Similarity of Documents, Distance Measures: Euclidean, Jaccard, Cosine , Edit and Hamming Distance with its Examples Mining Data Streams: Data Stream Management Systems, Data Stream Model, Examples of Data Stream Applications: Sensor Networks, Network Traffic Analysis Filtering streams: The Blooms filter. Link Analysis: PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: Page Rank Implementation Using MapReduce Frequent Itemset Mining: Market-Basket Model, Apriori Algorithm, Algorithm of Park-Chen-Yu	**14**	**CO5**
06	**Big Data Analytics Applications** Recommendation Systems: Introduction, A Model for Recommendation Systems: Collaborative-Filtering System, Content based system and its Examples Mining Social-Network Graphs: Social Networks as Graphs, Types of Social-Networks. Clustering of Social Graphs: Applying Standard Clustering Techniques, counting triangles using Mapreduce.	**7**	**CO6**
	Total	**42**	

Text Books:

4. Radha Shankarmani and M Vijayalakshmi ,"Big Data Analytics", Wiley
5. Alex Holmes ,"Hadoop in Practice‖", Manning Press, Dreamtech Press.
6. Dan McCreary and Ann Kelly ,"Making Sense of NoSQL – A guide for managers and the rest of us", Manning Press.

References:

1. Bill Franks, —Taming The Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics‖, Wiley
2. Chuck Lam, —Hadoop in Action‖, Dreamtech Press
3. Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, Bart Baesens , WILEY Big Data Series
4. https://onlinecourses.nptel.ac.in/noc25_cs131/preview

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ETPCL601	Electromagnetic and Antenna Lab	-	25	25	-	-	50	

Prerequisite:	
Course Objectives: The course aims to	
1	Provide hands-on experience in understanding electromagnetic field behavior and wave propagation through practical experiments.
2	Familiarize students with various antenna types and their characteristics such as radiation pattern, gain, and directivity.
3	Develop experimental skills in measuring antenna parameters like impedance, VSWR, and bandwidth.
4	Understand measurement instruments for antenna testing.
Course Outcomes: Learners will be able to	
1	Demonstrate antenna parameters through practical experiments and simulations.
2	Measure and analyze radiation patterns of different types of antennas (dipole, monopole, patch, horn, etc.).
3	Determine key antenna parameters such as gain, directivity, beamwidth, impedance, and polarization.
4	Design and simulate array antennas using electromagnetic design software/Hardware
5	Perform impedance matching and VSWR measurements of microstrip and aperature antenna network analyzers or equivalent instruments.
6	Work effectively in teams to plan, conduct, and report laboratory experiments in a structured format

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Study different Antenna parameters (Use: FSM, Spectrum Analyzer and VNA)	C01
02	Introduction to Different Antenna Types	C02
03	Study of Wire Antenna, (Radiation pattern of dipole, folded	C03

	dipole and Monopole antenna, various loops)	
04	Study of Directive antenna, Yagi-Uda Antenna and irs parameter	C03
05	Study of Broad-band Antenna, Log-periodic Antenna	C04
06	Study of Antenna Arrays (Broadside, End-fire, Parametric study for various arrays parameters)	C04
07	Study of Aperture Antennas (Parabolic/ Hyperbolic/ Horn , with or without Reflector)	C05
08	Study of Regular shaped Microstrip Antenna	C05
09	Small Project report can be considered as a part of term-work (Design and Simulation or validation).	C06
10	Case Study of Recent reported variations of Antenna types (Paper from reputed journal is to be referred and thoroughly study and present the report, maximum four students per group)	C06

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Oral & Practical Exam (25 Marks)

An Oral & Practical exam will be held based on entire syllabus.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ETPCL602	**Image Processing and Machine Vision Lab**	-	25	25	-	-	50	

Prerequisite: Signal and System, Discrete time signal processing	
Course Objectives: The course aims to	
1	Learn implementing basic theoretical concepts in Image Processing and Machine Vision using relevant software.
2	Illustrate the exposure to students to object recognition/ classification techniques in Machine Vision.
3	Facilitate students for understanding practical aspects of Image Processing and Machine Vision through an application
4	Analyse image processing and machine vision to practical case studies
Course Outcomes: Learners will be able to	
1	Experiment fundamentals of image processing on Gray level image
2	Enhance the quality of image using both spatial and frequency domain techniques for image enhancement
3	Analyse morphology operations on image
4	Apply segmentation on Gray level image using various algorithms
5	Learn and apply the classification methods on image
6	Perform the case study on color image

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
1	To implement Point processing operation on Gray scale image.	CO1
2	To implement low pass filter on given Gray scale image.	CO2
3	To implement high pass filter on given Gray scale image.	CO2
4	To perform histogram equalization on given image.	CO1
5	To analyse edge detection operators SOBEL and CANNY on given gray scale image.	CO4
6	To understand and implement Image resizing and Image cropping operation.	CO1
7	To perform morphological operations like EROSION, DILATION, OPENING, CLOSING on given Gray scale image.	CO3
8	To perform adaptive thresholding on given gray scale image.	CO4
9	To perform classification using k-means algorithm.	CO5
10	Any one Case Study: 1. Face recognition	CO6

	2. Finger print identification 3. License plate recognition	

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Oral & Practical Exam (25 Marks)

An Oral & Practical exam will be held based on entire syllabus.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem. Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ETPECL6011	Wireless Network Lab	-	25	-	-	-	25	

Prerequisite: Mobile Communication System	
Course Objectives: The course aims to	
1	Analyse performance of different wireless systems
2	Develope wireless applications
3	Understand and usuage of TRM, Cisco Packet tracer, NS2, Scilab simulation tools
4	Apply machine learning algorithm
Course Outcomes: Learners will be able to	
1	Apply network simulator tool to simulate different wireless systems and network topologies
2	Understand different types of wireless networks
3	Analyse wireless link performance
4	Apply networking topologies in different applications
5	Design and simulate sensor network
6	Develope wireless applications that utilizes aspect like handoff, mobility and quality of service using different wireless technologies

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Implementation of data transfer between three nodes using TCP and UDP using NS2	CO1
02	Implementation of wireless personal area network using Cisco packet tracer	CO2
03	Implementation WiFi handoff using NS2 Simulator	CO6
04	Implentation of dumbel shaped network for load balancing between multiple source and sink nodes using NS2	CO4
05	Configuration of Wireless Heterogeneous network using Cisco packet tracer	CO1

06	To find Bandwidth of a sub channel and different parameters of a OFDM WLAN system	CO6
07	Calculation of Link budget of a GSM1800 network using Scilab	CO3
08	To implement automation of a Web Camera using Motion Detector and IoT technology	CO6
09	Implementation of machine learning algorithm using Python	CO1
10	Implementation of sensor network using TRM model	CO5
11	Implementation of Bus & Ring topology using NS2 simulator	CO4
12	OFDM transmission and reception using SDR	CO6

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Oral & Practical Exam (25 Marks)

An Oral & Practical exam will be held based on entire syllabus.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ETPECL6012	Natural Language Processing Lab	-	25	-	-	-	25	

Prerequisite:	
Course Objectives: The course aims to	
1	Understand the fundamental steps involve in NLP
2	Gain hands on experience with text processing and analysis tools
3	Explore linguistic concept such as POS, tokenization and morphology
4	Familiarize with commonly used NLP libraries like NLKT and spaCy
Course Outcomes: Learners will be able to	
1	Prepossessed and analyse textual data effectively
2	Understand and apply NLP techniques such as stemming, tagging and parsing
3	Gain exposure to semantic relationship using WordNet
4	Perform basic NLP task using pre trained model and open source tool
5	Develop small scale NLP application like semantic analysis and translation
6	Understand real world application and challenges of NLP in communication system

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Perform tokenization, stopword removal, and stemming/lemmatization on sample text using NLTK or spaCy	C01
02	To Count word frequencies in a paragraph and visualize with a bar chart or word cloud.	C01
03	Study Tagging parts of speech for an English sentence and interpret the results	C02
04	To identify names of people, locations, and organizations in text using spaCy	C01
05	Identify Sentiment Analysis using Pre-trained Model	C04
06	Compare two sentences and find their semantic similarity score using spaCy or gensim	C04

07	Explore synonyms, antonyms, hypernyms, and hyponyms using WordNet.	C03
08	Build and display bigram or trigram model from sample text using tool TextRank	C05
09	Generate automatic summary of a paragraph simple text summirasation	C06
10	Perform Machine Translation using API using Google Translate API / transformers	C06

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Oral & Practical Exam (25 Marks)

An Oral & Practical exam will be held based on entire syllabus.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ETPECL6013	Satellite Communication Lab	-	25	-	-	-	25	

Prerequisite:	
Course Objectives: The course aims to	
1	Discuss the basics of satellite communications and different satellite communication orbits.
2	Provide an in-depth understanding of satellite communication system operation, launching techniques, satellite link design and earth station technology.
3	Explain the tools necessary for the calculation of basic parameters in a satellite communication system.
4	Review the state of the art in new research areas such as speech and video coding, satellite networking and satellite personal communications, mobile satellite communication, Laser satellite.
Course Outcomes: Learners will be able to	
1	Explain set up satellite communication,
2	Implement date transfer using satellite Link
3	Design parameter to transmit data from earth station to antenna
4	Analyze link budget of satellite signal for proper communication
5	Establish Direct PC to PC communication using Satellite Link.
6	Review various applications of satellite communications

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
1	Set up an active satellite link and demonstrate link fail operation.	CO1
2	Observe transmission and reception of audio and video signals and Data communication over satellite link.	CO1
	To study and setup the Active satellite link design through Transponder	CO2
3	Observe ransmission of Telemetry data like temperature and light intensity over satellite link.	CO3
4	Measure propagation delay of signal in satellite communication link.	CO3

5	Establish a satellite communication link and study of change in uplink and downlink frequency.	CO4
6	Calculate Link Power Budget of Satellite link	CO4
7	Select various PN codes like Gold, Barker and MLS in CDMA technology	CO5
8	Establish PC to PC communication link using RS232	CO5
9	Evaluate SNR in Satellite link.	CO4
10	Develope radiation pattern and calculate beamwidth for Yagi uda and folded dipole antenna.	CO3
11	Satellite Image processing using MATLAB.	CO6
12	Discuss performance of Different types satellite in future scope	CO6

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Oral & Practical Exam (25 Marks)

An Oral & Practical exam will be held based on entire syllabus.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
CEMDML601	Big Data Computing Lab	-	25	-	-	-	25	

Prerequisite: DBMS	
Course Objectives: The course aims to	
1	Describe an overview of an exciting growing field of Big Data analytics.
2	Discuss the challenges traditional data mining algorithms face when analyzing Big Data.
3	Explain the tools required to manage and analyze big data like Hadoop, NoSql MapReduce.
4	Tell the tools that will help them to solve complex real-world problems in decision support.
Course Outcomes: Learners will be able to	
1	Explain the motivation for big data systems and identify the main sources of Big Data in the real world.
2	Demonstrate an ability to use frameworks like Hadoop, NOSQL to efficiently store, retrieve and process Big Data for Analytics.
3	Build several Data Intensive tasks using the Map Reduce Paradigm
4	Apply several newer algorithms for Clustering Classifying and finding associations in Big Data
5	Design algorithms to analyze Big data like streams, Web Graphs and Social Media data.
6	Design and implement successful Recommendation engines for enterprises.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Case Study: on Study of Hadoop ecosystem	CO1
02	Programming exercises on Hadoop Using Hive, Pig, HBase, Sqoop NOSQL, MongoDB	CO2
03	Implementing simple algorithms in MapReduce Matrix, multiplication, Aggregates, joins, sorting, searching etc.	CO3
04	Implementing Algorithms using MapReduce (Any 2)	CO3

05	Implementing Frequent Item set Mining	CO4
06	Implementing Clustering algorithms Implementing Classification Algorithms	CO5
07	Big Data Applications (Any 2) ● Implementing Analytics on data streams ● Implementing Social Network Analysis Algorithms	CO6
08	Implementing Web Graph Algorithms Implementing recommendation Engines	CO6
09	Mini Project: One real life large data application to be implemented (Use standard Datasets available on the web) a) Twitter data analysis b) Fraud Detection c) Text Mining d) Recommendation Engines (list of datasets also given in the text book)	CO5,CO6

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Oral & Practical Exam (25 Marks)

An Oral & Practical exam will be held based on entire syllabus.

Useful Links:

1 https://www.coursera.org/learn/hadoop#syllabus
2 https://www.coursera.org/learn/introduction-mongodb#syllabus
3 https://www.coursera.org/learn/data-visualization-tableau?specialization=data-visualization#syllabus
4 https://www.coursera.org/learn/introduction-to-big-data-with-spark-hadoop#syllabus

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ETCEP601	**Mini Project II**	-	25	25	-	-	50	

Prerequisite: Electronic and digital devices , Mini Project I , Digital VLSI	
Course Objectives: The course aims to	
1	Train students for FPGA and Microcontroller (MSP430/ESP32/similar) based project implementation and management
2	Make students ready for Hardware related industry
3	Make students familiar with the VLSI and Microcontroller programming
4	Make students familiar with the targeted FPGA/Microcontroller design and implementation
Course Outcomes: Learners will be able to	
1	Identify the appropriate electronics devices, sensors, etc. required for given task
2	Write basic codes for FPGA and MSP430/ESP32
3	Apply the knowledge of interfacing different devices to FPGA and MSP430/ESP32
4	Design circuit for given problem.
5	Analyze circuit to troubleshoot
6	Write the Technical report

Guidelines for Mini Project

- Mini Project II is in two parts. Part A is FPGA Project and Part B is Microcontroller like MSP430/ESP32/similar.
- In Part A students has to do simulation using Verilog with FPGA hardware selection. In Part B students has to do complete hardware implementation using any of suggested microcontroller.
- Students shall form a group of 3 to 4 students.
- Mini Project Coordinator will assign Guide.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with Guide/supervisor/department faculty.
- Students shall submit implementation plan, which will cover weekly activity of mini project.
- In Project dairy weekly work progress to be mentioned, guide/supervisor will verify it and guide accordingly.
- Faculty supervisor may give inputs to students during mini project activity hour; however, focus shall be on self-learning.
- Review committee comments/changes/modification has to be incorporated by students and Guide will verify it.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.

- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format given by Mini Project coordinator.
- Focus is on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Project.
- Student should do online course or certification of FPGA/MSP430/ESP32

Guidelines for Assessment of Mini Project:

- **Term Work**
- The review/ progress monitoring committee will evaluate progress of work. Two reviews will be conducted.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks is described in the log book. Guide will award marks accordingly.
- Mini Project shall be assessed based on following criteria;
    a. Quality of survey/ need identification
    b. Clarity of Problem definition based on need.
    c. Feasibility of proposed problem solutions and selection of best solution
    d. Cost effectiveness
    e. Societal impact
    f. Effective use of skill sets and standard engineering norms
    g. Contribution of an individual's as member or leader
    h. Clarity in written and oral communication

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group.
- Students shall be motivated to participate in project competition.
- Mini Project shall be assessed based on following points;
    1. Quality of problem and Clarity
    2. Cost effectiveness and Societal impact
    3. Full functioning of working model as per stated requirements
    4. Effective use of skill sets and standard engineering norms
    5. Contribution of an individual's as member or leader
    6. Clarity in written and oral communication

Part A: Suggested FPGA (using Verilog) Projects

1) Shift-Add Multiplication
2) Hardware Multipliers
3) Programmed Multiplication
4) Shift-Subtract Division
5) CORDIC Algorithm
6) Design of functions such as reciprocal, square root, sine, cosine, exponential
7) Wallace Multiplier
8) 8- Bit ALU
9) Matrix Multiplication

10) Booths Multiplier
11) NRZ, NRZI etc coding techniques

Part B: Suggested Microcontroller like MSP430/ESP32/Similar Projects

1. Fingerprint Sensor based door locking system
2. Ball Tracking Robot
3. Web Controlled Home Automation
4. Line Follower Robot
5. Smart Phone Controlled Home Automation
6. Web Controlled Surveillance Robotic Car
7. Weight Sensing Automatic Gate
8. Home Security System with Email Alert
9. Obstacle Avoiding Robot using Ultrasonic Sensor
10. Web Controlled Notice Board
11. RF Remote Controlled LEDs
12. RFID Based Attendance System
13. Interactive Led-Mirror
14. Garage Door monitor
15. Classroom Automation
16. Digital Code Lock
17. Electronic Voting Machine
18. Dynamic Traffic Monitoring
19. Bus Indication
20. Remote Controlled Car

Project Domain according to Program outcome (PO):

POs	Title	Project Domain
PO1	Engineering Knowledge	Focus: Core fundamentals (maths, electronics, communication) Suitable Domains: ● Embedded Systems ● Signal Processing (DSP) ● Communication Systems Example Projects: ● Digital filter design using DSP ● Microcontroller-based automation system ● RF communication system
PO2:	Problem Analysis	Focus: Identifying and analyzing problems Suitable Domains: ● Data Analysis in Signals ● Communication Systems ● Fault Detection Systems Example Projects: ● Noise reduction in communication signals ● Network fault detection system ● Signal distortion analysis

PO3	Design / Development of Solutions	Focus: Designing real-world systems Suitable Domains: ● IoT ● Embedded Systems ● Robotics Example Projects: ● Smart home automation ● Smart irrigation system ● Obstacle avoiding robot
PO4	Conduct Investigations of Complex Problems	Focus: Experiments and data interpretation Suitable Domains: ● DSP ● Biomedical Signal Processing ● Communication Testing Example Projects: ● ECG signal analysis ● Audio signal filtering ● Wireless signal performance analysis
PO5	Engineering Tool Usage	Focus: Use of modern tools/software Suitable Domains: ● VLSI / FPGA ● MATLAB-based DSP ● IoT with cloud Example Projects: ● FPGA-based digital system ● MATLAB-based image processing ● IoT cloud dashboard system
PO6	The Engineer and The World	Focus: Social impact Suitable Domains: ● Smart City Solutions ● Public Safety Systems ● Healthcare Electronics Example Projects: ● Smart traffic control system ● Emergency alert system ● Women safety device
PO7	Ethics	Focus: Ethical engineering & data security Suitable Domains: ● Cybersecurity ● Secure Communication Example Projects: ● Encrypted communication system ● Biometric authentication system ● Secure IoT system
PO8	Individual and Collaborative Team work	Focus: Team-based development Suitable Domains: ● Robotics ● Large IoT Systems ● Multimodule Embedded Projects Example Projects:

		● Autonomous robot ● Smart campus system Industrial automation system
PO9	Communication	Focus: Presentation & reporting Suitable Domains: ● Any domain with dashboards/UI ● Web-integrated IoT systems Example Projects: ● IoT dashboard system ● Data visualization platform ● Web-based monitoring system
PO10	Project Management and Finance	Focus: Planning, budgeting Suitable Domains: ● Industrial Projects ● Smart Systems with scalability Example Projects: ● Smart energy management system ● Industrial monitoring system ● Inventory automation system
PO11	Life-Long Learning	Focus: Learning new technologies Suitable Domains: ● AI + IoT ● 5G / Advanced Communication ● Emerging Technologies Example Projects: ● AI-based smart surveillance ● 5G communication model ● Edge AI system

Continuous Internal Evaluation (50 Marks)

1. Verilog Project implementation: 10 Marks
2. MSP430/ESP32 based hardware Project implementation : 25 Marks
3. Course successful completion certificate (Verilog/MSP430/ESP32): 10 Marks
4. Evaluation of Weekly Progress: 05 Marks

Oral & Practical Exam (25Marks)

An Oral and Practical Exam will be held based on both projects Part A and B.

Suggested Courses:

Verilog Courses: NPTEL, Udemy, Maven Silicon, Coursera , etc

Microcontroller (MSP430/ESP32/similar) Courses: Udemy , Coursera, DroneBot Workshop Careerpluz,, Circuit Digest, Codementor, etc

Suggested Competitions

1. SIH (Smart India Hakethon)
2. Tantragyan
3. Avishkar
4. Anveshana
5. Ideathon
6. CIIA

7. Government Swadeshi Microprocessor Challenge
8. IICDC – TI challenge
9. Sankalp Semiconductors Hackathons