M.D. UNIVERSITY, ROHTAK

SCHEME OF STUDIES AND EXAMINATION
(Under NEP-2020)

Bachelor of Technology
Electronics and Communication Engineering
Common with
Electronics and Telecommunication Engineering

'H' Scheme (Under NEP-2020)

Effective from:

Academic Session 2026-27 (for 2nd Year)

1. Definition of Credit:

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week	0.5 credits
2 Hours Practical (Lab) per week	1 credit

2. Structure of the Undergraduate Engineering program:

Sr. No.	Category
1	Humanities and Social Sciences including Management courses
2	Basic Science Courses
3	Engineering Science courses
4	Program Core Courses (Branch specific)
5	Professional Elective courses relevant to chosen specialization/branch
6	Open Elective Courses (from Humanities, Technical Emerging or other Subjects)
7	Project work, Seminar and Internship in Industry or elsewhere
8	Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Knowledge Tradition] etc. (non-credit)

3. Course code and definition:

Course Code	**Definitions**
L	Lecture
T	Tutorial
P	Practical
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses
PCC	Professional Core Courses
LC	Laboratory Courses
MC	Mandatory Courses
PT	Practical Training
PEC	Professional Elective courses
OEC	Open Elective courses
PRROJ/SEM	Seminar Employment Enhancement Courses (Project/Summer Internship/ Seminar)

PROGRAM OUTCOMES (PO)

Engineering Graduates will be able to:

PO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods, including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities with an understanding of the limitations.

PO6. Analyse and evaluate societal and environmental aspects while solving complex engineering problems, considering their impact on sustainability with reference to economy, health, safety, legal frameworks, culture, and the environment.

PO7. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO8. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO9. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO10. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO11. Life-long learning: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (ECE)

PSO 1: Analysis, Design, and Development of Electronic Systems: An ability to analyze, design, and develop solutions for complex engineering problems by applying fundamental and advanced knowledge of Electronics and Communication Engineering, including electronic circuits, communication systems, signal processing, embedded systems, and VLSI technologies.

PSO 2: Application of Modern ECE Tools and Technologies An ability to select, analyze, and apply modern electronic and communication tools, software, instruments, and technologies to solve real-world engineering challenges and contribute effectively to sectors such as telecommunications, healthcare, defense, automation, smart systems, and industrial development.

PSO 3: Professional Skills, Innovation, and Sustainability: An ability to work effectively as an individual and as a member of multidisciplinary teams, demonstrating technical, social, ethical, environmental, and sustainability awareness. Graduates will be capable of developing innovative,

cost-effective, and sustainable solutions by utilizing emerging technologies, modern engineering practices, and lifelong learning skills.

Semester-3

Sr. No.	Course Code	Course Title	Hours per week			Total Contact Hrs. per week	Credit	Examination Scheme (Marks)				Duration of Exam (Hours)
			L	T	P			Internal awards	Theory	Practical	Total	
1	26PCC-ECE-201-H	Electronic Devices	3	1	0	4	**4**	30	70		100	3
2	26PCC-ECE-203-H	Analog and digital Communication	3	1	0	4	**4**	30	70		100	3
3	26PCC-ECE-205-H	Signals and Systems	3	1	0	4	**4**	30	70		100	3
4	26PCC-ECE-207-H	Network Theory	3	1	0	4	**4**	30	70		100	3
5	PEC	Professional Elective courses –I	3	0	0	3	**3**	25	50		75	3
6	26LC- ECE-209-H	Electronic Devices Lab	0	0	2	2	**1**	5		20	25	3
7	26LC- ECE-211-H	Analog and digital communication Lab	0	0	2	2	**1**	5		20	25	3
8	26LC-ECE-213-H	Network Theory Lab	0	0	2	2	**1**	5		20	25	3
9	26AU-ENV-202-H	Environmental Science	2	**0**	1	3	**0**	Refer Note 1				
					Total	28	22				550	
	For Honors course											
1	26PCC-ECE-215-H	Electronic Measurement and Instrumentation	3		0	3	**3**	25	50		75	3
2	26LC-PCC-ECE-217-H	Electronic Measurement and Instrumentation Lab	0		2	2	**1**	5		20	25	3
					Total	**5**	4				100	

Professional Elective courses-I

26PCC-AIML-222-H	Introduction to Machine Learning
26PEC-ECE-219-H	Probability and Stochastic Process
26PEC-EE-206-H	Soft Computing

Note-1:26AU-ENV-202-H is a mandatory non–credit course in which students must obtain passing marks in theory. The marks in this qualifying paper will not be included in determining the percentage of marks obtained for the award of a degree. However, these marks will appear on the student detailed marks certificate.

Marks Distribution:

- Internal Assessment: 30 marks
- Theory Examination: 70 marks

The institute will conduct the theory examination at its own level

Semester-4

Sr. No.	Course Code	Course Title	Hours per week			Total Contact Hrs. per week	Credit	Examination Scheme (Marks)				Duration of Exam (Hours)
			L	T	P			Internal awards	Theory	Practical	Total	
1	26PCC-ECE-202-H	Analog Circuits	3	1	0	4	**4**	30	70		100	3
2	26PCC-ECE-204-H	Microprocessors and Interfacing	3	1	0	4	**4**	30	70		100	3
3	26PCC-ECE-206-H	Digital Electronics	3	0	0	3	**3**	25	50		75	3
4	26PCC-ECE-208-H	Electromagnetic Waves	3	1	0	4	**4**	30	70		100	3
5	26BSC-MATHECE-204-H	Numerical Techniques	3	0	0	3	**3**	25	50		75	3
6	26PCC-CSE-201-H	Data Structures & Algorithms	3		0	3	**3**	25	50		75	3
7	26LC-ECE-210-H	Analog Circuits Lab	0	0	2	2	**1**	5		20	25	3
8	26LC-ECE-212-H	Microprocessors and Interfacing Lab	0	0	2	2	**1**	5		20	25	3
9	26LC-ECE-214-H	Digital Electronics Lab	0	0	2	2	**1**	5		20	25	3
					Total	27	24				600	
	For Honors course											
1	26PCC-ECE-216-H	Speech and Audio Processing	3		0	3	**3**	25	50		75	3
2	26LC-ECE-218-H	PCB & Workshop Laboratory	0		2	2	**1**	5		20	25	3
					Total	**5**	4				100	

Note-: At the end of the 4th semester, each student has to undergo Practical Training of 4/6 weeks in an Industry/ Institute/ Professional organization/ Research Laboratory/ training centre, etc., and submit a typed report along with a certificate from the organization& its evaluation shall be carried out in the 5th Semester.

The students of B.Tech working Professenols course have to submit training/project report of their respective company/organization for the period of summer training/ industrial training for the evaluation purpose.

Course code	26PCC-ECE-201-H				
Category	Program Core Course				
Course title	**Electronic Devices**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester-III**
	3	1	0	4	
Classwork	30 Marks				
Examination	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Objectives:

1. To familiarize the student with the principal of operation, analysis and design of junction diode, BJT and FET transistors and amplifier circuits.
2. To understand diode as a rectifier, clipper and clamper circuit.
3. To study basic principal of voltage regulators and its various types.

COURSE OUTCOMES (CO):

By the end of the Course, Students will be able to:

CO1: Understand the principles of semiconductor Physics and apply it to electronic devices.

CO2: Appreciate different devices for different applications.

CO3: Understand and utilize the mathematical models of semiconductor devices for circuits.

CO4: Understand the basic processes required to regulate the fluctuations of power supply.

CO - PO mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2			1						2	**3**	**2**	**1**
CO2	2	2	2		2	1					1	**2**	**3**	**2**
CO3	3	3	2	2	2						2	**3**	**2**	**2**
CO4	3	2	3	1	2	1					1	**3**	**2**	**3**
WT. AVG	2.75	2.5	2.3	1.5	1.75						1.5	2.75	2.25	2
Overall Mapping of Subject														2.33

Note: The examiner will set a total of 9 questions. Question one will carry questions from all units, and the remaining eight questions will be set by taking two questions from each unit. The students have to attempt five questions in total, with the first being compulsory and selecting one from each unit. All questions will carry equal marks.

UNIT I

Introduction to Semiconductor Physics: Energy bands in intrinsic and extrinsic silicon; Fermi Level, Fermi Level in Intrinsic and Extrinsic Semiconductor, Carrier transport: diffusion current, drift current, continuity equation.

P-N JUNCTION DIODE: Working of diode, Potential barrier, diode equation, I-V characteristics, Rectifier circuits, clipping and clamping circuits, Voltage multiplier, Avalanche and Zener breakdown.

UNIT II

TRANSISTOR: Bipolar junction transistor: operation, characteristics, Ebers-moll model of transistor, CE, CB, CC configurations, Darlington pair amplifier, testing of transistor.

TRANSISTOR BIASING:load line analysis, Operating point, bias stability, fixed bias, collector to base bias, self-bias, emitter bias, voltage divider bias, bias compensation, thermistor &sensistor compensation.

UNIT III

FIELD EFFECT TRANSISTORS: Junction field effect transistor, pinch off voltage, VI characteristics, small signal model, MOSFET Enhancement & Depletion mode, VMOSFET, source follower, biasing of FET, applications of FET as a voltage variable resistor (VVR).

UNIT IV

VOLTAGE REGULATOR: DC regulated power supply, Zener diode shunt voltage regulator, Transistor series and shunt voltage regulator, IC voltage regulators.

Special Purpose Devices: Working and characteristics of LED, UJT, Schottky diode, Thyristor, DIAC TRIAC, Photodiode.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Electronic Devices & Circuits	Dr. Malaya Kumar Nath	NIT Puducherry
2	Semiconductor Devices and Circuits	Prof. SanjivSambandan	IISc, Bengaluru

Text/ Reference Books

1. *Jacob Millman* and D. Halkias, "Electronic Devices and Circuits" McGraw Hill.
2. Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory" Pearson.
3. G. Streetman, and S. K. Banerjee, Solid State Electronic Devices, 7th edition, Pearson,2014.
4. Donald Neamen ,Dhrubes Biswas "Semiconductor Physics and Devices" McGraw-Hill Education
5. S. M. Sze and K. N. Kwok, Physics of Semiconductor Devices, 3rd edition, John Wiley &Sons, 2006.
6. C.T. Sah, Fundamentals of solid state electronics, World Scientific Publishing Co Inc, 1991.
7. Y. Tsividis and M. Colin, Operation and Modeling of the MOS Transistor. Oxford Univ. Press, 2011.

8. A.K. Maini, N. Maini, All-in-One Electronics Simplified, Khanna Book Publishing, New Delhi, 2021.
9. A.K. Maini, Analog Electronics, Khanna Book Publishing, New Delhi, 2022.

Course code	26PCC-ECE-203-H				
Category	Program Core Course				
Course title	**Analog and Digital communication**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester-III**
	3	1	0	4	
Classwork	30 Marks				
Examination	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Objectives

To introduce the fundamentals of communication systems, noise, and random processes used in signal transmission.

To understand and analyzeanalog modulation techniques including AM and FM and their performance characteristics.

To study pulse communication systems and waveform coding techniques for efficient signal transmission.

To analyze and compare digital communication systems, digital modulation techniques

Course Outcomes

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

CO1 (Unit–I): Explain the basic structure of communication systems and analyze the effect of noise and random processes on signal transmission.

CO2 (Unit–II): Analyze amplitude and angle modulation techniques and compare their spectral and noise performance.

CO3 (Unit–III): Evaluate pulse communication and waveform coding techniques such as PAM, PCM, DPCM, and delta modulation.

CO4 (Unit–IV): Analyze digital modulation schemes and assess their performance in terms of bandwidth efficiency, power efficiency, and inter-symbol interference.

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	2	1	–	–	–	–	–	–	–	2	**3**	**2**	**1**
CO2	3	3	2	–	–	–	–	–	–	–	2	**3**	**3**	**2**
CO3	3	3	2	–	1	–	–	–	–	–	2	**3**	**2**	**2**
CO4	3	3	2	1	1	–	–	–	–	–	3	**3**	**2**	**3**
WT. AVG	3	2.75	1.75	1	1						2.25	3	2.25	2
Overall Mapping of Subject														2.42

Note: The examiner will set a total of 9 questions. Question one will carry questions from all units, and the remaining eight questions will be set by taking two questions from each unit. The students have to attempt five questions in total, with the first being compulsory and selecting one from each unit. All questions will carry equal marks.

Course Contents:

Unit–I:

Introduction to communication systems, basic block diagram of a communication system, need for modulation and demodulation, radio frequency spectrum, classification of signals, modes and media of communication, analog and digital communication systems and their comparison, limitations and advantages of communication systems,

noise in communication systems, sources of noise including external and internal noise, noise modeling, properties of white noise, role of noise in communication systems.

Unit–II:

Linear modulation techniques, basic definition and derivation of amplitude modulation and modulation index, modulation and demodulation of AM, suppressed carrier modulation, double sideband suppressed carrier (DSB-SC), single sideband suppressed carrier (SSB-SC), vestigial sideband modulation (VSB) and demodulation, comparison of various AM systems,

Angle modulation, basic definition and derivation of frequency and phase modulation and modulation index, generation of FM waves, comparison between PM and FM, frequency spectrum of FM signals, bandwidth requirements and Carson's rule, types of FM, vector representation of FM, universal curve, multiple FM, demodulation of FM and PM waves, comparison between AM and FM systems.

Unit–III:

Pulse communication fundamentals, sampling theory and sampling theorem, practical sampling and aliasing, pulse analog modulation techniques, pulse amplitude modulation (PAM), pulse width modulation (PWM), pulse position modulation (PPM), generation and demodulation of PAM, PWM and PPM signals, comparison of pulse analog modulation schemes, time division multiplexing (TDM) and frequency division multiplexing (FDM),

Pulse digital modulation techniques, elements of pulse code modulation (PCM), quantization and encoding, noise in PCM systems, signal-to-quantization noise ratio, bandwidth requirements of PCM systems, differential pulse code modulation (DPCM), delta modulation (DM), adaptive delta modulation, performance comparison of PCM, DPCM and DM systems.

Unit–IV:

Digital baseband and bandpass communication systems, digital modulation techniques, amplitude shift keying (ASK), frequency shift keying (FSK), phase shift keying (PSK), binary phase shift keying (BPSK), differential phase shift keying (DPSK), quadrature phase shift keying (QPSK), minimum shift keying (MSK),

M-ary modulation techniques including M-ary PSK, M-ary QAM and M-ary FSK, comparison of digital modulation schemes in terms of bandwidth efficiency, power efficiency and bit error rate performance, inter-symbol interference (ISI) and Nyquist criterion.

S. No.	NPTEL Course Name	Instructor(s)	Host Institute	Relevant Units Covered	Course Link
1	Communication Systems	Prof. Aditya K. Jagannatham	IIT Kanpur	Unit I, II, III, IV	https://nptel.ac.in/courses/117106115
2	Analog Communication	Prof. S. N. Merchant	IIT Bombay	Unit II	https://nptel.ac.in/courses/117106103
4	Principles of Communication Engineering	Prof. A. Chatterjee	IIT Kharagpur	Unit I, II, III	https://nptel.ac.in/courses/108105080
5	Error Control Coding	Prof. B. SundarRajan	IISc Bangalore	Unit IV	https://nptel.ac.in/courses/117106078

Text/Reference Books:

1. B.P.Lathi,Zhi Ding “Modern Digital and Analog Communication”, Oxford, 4th Edition,2011

2. Haykin S., "Communications Systems", John Wiley and Sons, 2001.

3. Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education,

4. Taub H. and Schilling D.L., "Principles of Communication Systems",Tata McGraw Hill,

5. Proakis J.G., ``Digital Communications", 4th Edition, McGraw Hill, 2000.

6. R. Anand, Communication Systems, Khanna Book Publishing Company, 2011.

Course code	26PCC-ECE-205-H				
Category	Program Core Course				
Course title	**Signals and Systems**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester-III**
	3	1	0	4	
Classwork	30 Marks				
Examination	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course objectives

1. **To understand** the fundamental concepts of signals and systems and their relevance in engineering applications.
2. **To explain** the classification and characteristics of continuous-time and discrete-time signals and systems.
3. **To analyze** linear shift-invariant systems using impulse response, convolution, and system properties.
4. **To apply** frequency-domain and transform-domain techniques for the analysis of signals and systems.

COURSE OUTCOMES (CO):

By the end of the Course, Students will be able to:

CO1: Explain the fundamental concepts of signals and systems, including classification and representation of continuous-time and discrete-time signals.

CO2: Analyze system properties such as linearity, time invariance, causality, and stability, and determine the response of linear shift-invariant systems using impulse response and convolution.

CO3: Apply Fourier Series, Fourier Transform, and Discrete-Time Fourier Transform techniques to analyze signals and systems in the frequency domain.

CO4: Use Laplace and Z-Transform methods to analyze continuous-time and discrete-time systems and solve differential and difference equations.

CO - PO mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	2	1	-	2	-	-	-	-	-	2	**3**	**2**	**1**
CO2	3	2	2	2	2	1	-	1	1	-	2	**3**	**3**	**2**
CO3	3	2	2	2	2	-	-	1	1	-	2	**3**	**3**	**2**
CO4	3	3	3	3	2	1	-	1	1	-	3	**3**	**3**	**3**
WT. AVG	3	2.25	2	2.3	2	1		1	1		2.25	3	2.75	2
Overall Mapping of Subject														2.58

Note: The examiner will set a total of 9 questions. Question one will carry questions from all units, and the remaining eight questions will be set by taking two questions from each unit. The students have to attempt five questions in total, with the first being compulsory and selecting one from each unit. All questions will carry equal marks.

Unit–I

Introduction to Signals:Signals and systems in everyday life and in various branches of engineering and science: electrical, mechanical, hydraulic, thermal, and biomedical examples.**Elementary signals:** Unit step, unit impulse, ramp signal, Sinusoidal and complex exponential signals, Time-limited and non-time-limited signals.

Classification of signals: Continuous-time and discrete-time signals,Energy and power signals, Deterministic and stochastic signals, Periodic and aperiodic signals, Even/Symmetric & Odd/Anti symmetric signals,Causal, Non causal & Anti causalsignals

Basicsignal operations **on** Continuous-time and discrete-time signals:time shifting, time scaling, time reversal, amplitude scaling

Unit–II

System properties: Linearity (additivity and homogeneity), Time invariance, Causality, Stability, **System classification:**Linear and nonlinear system, Time-invariant and time-variant systems, Causal and non-causal systems, stable and unstable systems, Memoryless and dynamic systems.

Linear time-Invariant Systems: Continuous-time and discrete-time linear time-invariant (LTI) systems, Impulse response and step response of LTI systems, Convolution integral and convolution sum, Input–output relationship of LTI systems.

Unit–III

Fourier Series: Representation of periodic continuous-time signals using Fourier Series, Exponential Fourier Series and computation of Fourier coefficients for periodic and exponential Fourier series, Conditions for existence of Fourier Series (Dirichlet conditions)

Fourier Transform: Definition of **continuous-time Fourier Transform (CTFT)**, existence of Fourier Transform, Fourier Transform of standard continuous-time signals, properties of Fourier Transform including linearity, time shifting, frequency shifting, time scaling, duality, differentiation and integration, **convolution property**, multiplication property,

DTFT: Definition of Discrete-Time Fourier Transform,DTFT of standard discrete-time signals, Properties of DTFT

Unit–IV

Laplace Transform: Definition of Laplace Transform, Bilateral and unilateral Laplace Transform, Conditions for existence, Region of Convergence (ROC), Laplace Transform of standard signals, Properties of Laplace Transform, Inverse Laplace Transform using partial fractions,Solution of linear differential equations using Laplace Transform, Relationship between Laplace Transform and Fourier Transform

Z-**Transform:**Definition of Z-Transform, Bilateral and unilateral Z-Transform, Region of Convergence (ROC), Z-Transform of standard discrete-time signals, Properties of Z-

Transform, Inverse Z-Transform usingpartial fraction expansion, Solution of linear difference equations using Z-Transform,Relationship between Z-Transform and DTFT.

Course Name	Instructor / Institute	Platform Link
Signals and Systems (NOC)	Prof. Hitesh Shrimali& Prof. Kushal K. Shah – IIT Mandi& IISER Bhopal	https://onlinecourses.nptel.ac.in/noc25_ee78/preview (NPTEL Online Courses)
Principles of Signals and Systems (NPTEL)	Prof. Aditya K. Jagannatham – IIT Kanpur	https://nptel.ac.in/courses/108104100 (NPTEL Online Courses)
Signals and Systems (Swayam / NPTEL)	Prof. Hitesh Shrimali& Prof. Kushal K. Shah	https://onlinecourses.nptel.ac.in/noc26_ee79/preview (NPTEL Online Courses)

Text/Reference books:

1. R. Anand, Signals and Systems, Khanna Publishing House, 2019.

2. A.V. Oppenheim, A.S. Willsky and I.T. Young,"Signals and Systems", Prentice Hall,

3. R.F. Ziemer, W.H. Tranter and D.R. Fannin, "Signals and Systems - Continuous and Discrete", 4th edition, Prentice Hall, 1998.

4. Papoulis, "Circuits and Systems: A Modern Approach", HRW, 1980.

5. B.P. Lathi, "Signal Processing and Linear Systems", Oxford University Press, c1998.

6. Douglas K. Lindner, "Introduction to Signals and Systems", Mc-Graw Hill International Edition: c1999.

7. Simon Haykin, Barry van Veen, "Signals and Systems", John Wiley and Sons (Asia)

Course code	26PCC-ECE-207-H				
Category	Program Core Course				
Course title	**Network Theory**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester-III**
	3	1	0	4	
Classwork	30 Marks				
Examination	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Objectives:

1. Develop a strong foundation in electrical network fundamentals and systematic analysis techniques such as node and mesh methods for DC and AC circuits.

2. Enable students to apply network theorems, source transformation, and duality concepts for simplifying and analyzing complex electrical networks.

3. Provide understanding of steady-state and transient responses of linear networks using Fourier series and Laplace transform techniques.

4. Introduce the concepts of network functions, poles and zeros, resonance, and frequency response for analyzing system behavior in the s-domain.

COURSE OUTCOMES (CO):

By the end of the Course, Students will be able to:

CO1: Apply node and mesh analysis techniques to solve DC and AC electrical networks.
CO2: Analyze electrical networks using network theorems and source transformation techniques.
CO3: Evaluate steady-state response of electrical networks using Fourier series and three-phase power analysis.
CO4: Apply Laplace transforms to analyze transient behaviour of RL, RC, and RLC circuits with and without initial conditions.

CO - PO mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	1	2	2	-	-	-	-	-	1	**3**	**2**	**1**
CO2	3	3	2	2	2	-	-	-	-	-	1	**3**	**3**	**1**
CO3	3	3	2	2	2	-	-	-	-	-	1	**3**	**2**	**2**
CO4	3	3	2	3	2	-	-	-	-	-	1	**3**	**3**	**1**
WT. AVG	3	3	1.75	2.25	2						1	3	2.5	1.25
Overall Mapping of Subject														2.25

Note: The examiner will set a total of 9 questions. Question one will carry questions from all units, and the remaining eight questions will be set by taking two questions from each unit. The students have to attempt five questions in total, with the first being compulsory and selecting one from each unit. All questions will carry equal marks.

UNIT I

Node and Mesh Analysis: Kirchhoff's laws, Node and mesh equations, Matrix approach of complicated network containing voltage and current sources, and reactances, source transformation and duality. Network theorem: Superposition, Reciprocity, Thevenin's, Norton's, Maximum power Transfer, compensation and Tallegen's theorem as applied to AC. circuits.

UNIT II

Trigonometric and exponential Fourier series: Discrete spectra and symmetry of waveform, steady state response of a network to non-sinusoidal periodic inputs, power factor, effective values, Fourier transform and properties, continuous spectra**.**

UNIT III

Laplace transforms and properties: Partial fraction, singularity functions, waveform synthesis, analysis of RC, RL, and RLC networks with and without initial conditions with Laplace transforms evaluation of initial conditions.

Transient behaviour: concept of complex frequency, Driving points and transfer functions, Poles and zeros of immittance function, their properties, Sinusoidal response from pole-zero integral solutions.Behaviors of series and parallel resonant circuits

UNIT IV

Two port network and interconnections: Characteristics and parameters of two port networks, Network Configurations, short-circuit Admittance parameters, open-circuit impedance parameters, Transmission parameters, hybrid parameters, condition for reciprocity & symmetry, Inter-relationships between parameters of two-port network sets, Inter-connection of two port networks.,

Introduction to band pass, low pass, high pass and band reject filters.

Network topology: Concept of Tree, Branch, Tree link, Incidence matrix, Tie-set matrix and Loop currents, Cut-set matrix

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Network Analysis	Prof. Tapas Kumar Bhattacharya	IIT Kharagpur
2	Principal of signal and system	Prof. Aditya K. Jagannatham.	IIT Kanpur

Text/ Reference Books

1. Van, Valkenburg.; "Network analysis"; Prentice hall of India, 2000

2. F. F. Kuo , "Network Analysis & Synthesis", John Wiley & Sons Inc 3. Alexander, Sadiku, "Fundamentals of Electric Circuits", McGraw-Hill Education

3. Sudhakar, A., Shyammohan, S. P.; "Circuits and Network"; Tata McGraw-Hill New Delhi, 1994

4. A William Hayt, "Engineering Circuit Analysis" 8th Edition, McGraw-Hill Education

5. Ashfaq Husain, Networks and Systems, Khanna Book Publishing, 2021.

6. A. Chakrabarti, "Circuit Theory: Analysis and Synthesis", Sixth Edition, Dhanpat Rai& Co., 2014.

7. D. Roy Choudhary, "Networks and Systems", Second Edition, New Age International, 2013.

Course code	26LC-ECE-209-H				
Category	Program Core Course				
Course title	**Electronic Devices Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester-III**
	0	**0**	**2**	**1**	
Internal Lab	05 Marks				
External lab	20 Marks				

Total	25Marks
Duration of Exam	03 Hours

Course Objective

To impart the practical knowledge of basic electronic devices and their applications

Course Outcomes

CO1: To teach the students how to experimentally plot the VI characteristics of various diodes such as p-n diode, zener diode etc. find the threshold voltage and zener breakdown voltage from the VI curve.
CO2: To experimentally analyze different type of rectifiers and calculation of ripple factors.
CO3: To experimentally teach the students the concept of different configurations of regulated power supplies using Zener diode.
CO4: To teach the students how to experimentally find the values of various parameters of Transistor such as voltage gain, current gain etc.

CO - PO mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	2	2		3	3				2		1	**2**	**3**	**1**
CO2	2	2	2	3	3				2		1	**2**	**3**	**1**
CO3	2	2	3	3	3	1			2		1	**3**	**3**	**2**
CO4	3	3	2	3	3			2	2		1	**3**	**3**	**2**
WT. AVG	2.25	2.25	2.3	3	3	1		2	2		1	2.5	3	1.5
Overall Mapping of Subject														2.33

Perform minimum 8 experiments from list given below or hands on experiments related to the course contents of Electronic Devices.

List of experiments:

1 To study the VI characteristics of p-n diode in forward and reverse bias and find the threshold voltage from the VI curve.

2 To study the operation of Zener diode as a voltage regulator.

3 To study the operation of half-wave and full wave rectifiers and calculate their ripple factor values.

4 To study the operation of series and parallel Clippers using P-N junction diodes.

5 To study the operation of clampers using P-N junction diodes.

6 To experimentally plot the input and output characteristics of a given BJT transistor in CE configuration and calculate its various parameters.

7 To experimentally plot the input and output characteristics of a given BJT transistor in CB configuration and calculate its various parameters.

8 To study the transfer and drain characteristics of JFET and calculate its various parameters.

9 To study the transfer and drain characteristics of D-MOSFET and calculate its various parameters.

10 To study the transfer and drain characteristics of E-MOSFET and calculate its various parameters.

11 To study the Zener diode as a transistor series voltage regulator.

12 To study the Zener diode as a transistor shunt voltage regulator.

13 To study IC regulators.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. N	Experiment Name	Experiment Link(s)
1.	VI characteristics of diode	https://be-iitkgp.vlabs.ac.in/exp/characteristics-diode/
2.	Half wave rectifier	https://be-iitkgp.vlabs.ac.in/exp/half-wave-rectification/
3.	Full wave rectifier	https://be-iitkgp.vlabs.ac.in/exp/full-wave-rectification/
4.	BJT common-emitter-characteristics	https://be-iitkgp.vlabs.ac.in/exp/common-emitter-characteristics/
5	BJT common-base-characteristics	https://be-iitkgp.vlabs.ac.in/exp/common-base-characteristics/
6	BJT CE-amplifier	https://be-iitkgp.vlabs.ac.in/exp/ce-amplifier/
7	Zener diode voltage regulator	https://be-iitkgp.vlabs.ac.in/exp/voltage-regulator/

Course code	26LC-ECE-211-H				
Category	Program Core Course				
Course title	**Analog and Digital Communication Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester-III**
			2	2	
Classwork	05 Marks				
Examination	20 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

Course Objectives:

1. To provide practical understanding of **analog modulation and demodulation techniques** through waveform analysis and parameter evaluation.
2. To develop hands-on skills in **digital modulation techniques** used in modern communication systems.

3. To familiarize students with **pulse modulation techniques** and their practical implementation.
4. To enhance **technical communication, presentation, and lifelong learning abilities** through seminars on advanced communication systems.

COURSE OUTCOMES

CO1. Analyze and interpret waveforms of **analog modulation and demodulation techniques** such as AM, FM, and PM, and determine key parameters like modulation index.

CO2. Implement and analyze**digital modulation techniques** including ASK, FSK, and PSK, and evaluate their performance through waveform observation.

CO3. Demonstrate and evaluate **pulse modulation techniques** such as PAM, PWM, PPM, PCM, and Delta Modulation used in communication systems.

CO4. Effectively present and explain concepts related to **advanced communication systems**, demonstrating professional communication skills and an orientation toward lifelong learning.

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	2	–	2	2	–	–	–	–	–	–	**3**	**2**	-
CO2	3	2	2	2	3	–	–	–	–	–	–	**3**	**3**	-
CO3	3	2	2	2	3	–	–	–	–	–	–	**3**	**3**	-
CO4	–	–	–	–	–	–	–	2	3	–	3	-	**2**	**3**
WT. AVG	3	2	2	2	3	-		2	3		3	3	2.5	3
Overall Mapping of Subject														2.83

1. To study and waveform analysis of amplitude modulation and determine the modulation index of amplitude modulation.

2. To study and waveform analysis of amplitude demodulation by any method.

3. To study and waveform analysis of frequency modulation and determine the modulation index of frequency modulation.

4. To study and waveform analysis of frequency demodulation by any method. 5. To study Amplitude Shift Keying (ASK) modulation.

5. To study Frequency Shift Keying (FSK) modulation.

6. To study Phase Shift Keying (PSK) modulation.

7. To study and waveform analysis of phase modulation.

8. To study Phase demodulation.

9. To study Pulse code modulation.

10. To study Pulse amplitude modulation and demodulation.

11. To study Pulse width modulation.

12. To study Pulse position modulation.

13. To study delta modulation.

14. To deliver a seminar by each student on ADVANCE COMMUNICATION SYSTEM.

Course code	26LC-ECE-213-H				
Category	Program Core Course				
Course title	**Network Theory Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester-III**
	0	**0**	**2**	**1**	
Internal Lab	05 Marks				
External lab	20 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

Course Objective

1.**Apply and verify** fundamental network theorems such as Superposition, Thevenin's, Norton's, and Maximum Power Transfer in AC and DC circuits.
2. **Analyze transient and steady-state responses** of first-order (RC, RL) and second-order (RLC) circuits using experimental methods.
3. **Evaluate frequency response characteristics** of passive filters and determine key parameters such as resonance frequency, half-power frequency, and bandwidth.
4. **Determine and interpret two-port network parameters** (Z, Y, ABCD) and study the effect of loading in interconnected networks.

Course Outcomes

CO1: Apply network theorems (Superposition, Thevenin's, Norton's, and Maximum Power Transfer) to analyze AC and DC circuits experimentally.
CO2: Analyze transient response of first-order circuits (RC and RL) and resonance characteristics of RLC circuits.
CO3: Evaluate frequency response characteristics of low-pass, high-pass, and band-pass filters.
CO4: Determine and verify two-port network parameters (Z, Y, and ABCD) and study loading effects.

CO - PO mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3	2	-	-	-	-	-	2	**3**	**2**	**1**
CO2	3	3	2	3	2	-	-	-	-	-	2	**3**	**2**	**1**
CO3	3	3	2	3	2	-	-	-	-	-	2	**3**	**2**	**2**
CO4	3	3	3	3	2	-	-	-	-	-	2	**3**	**3**	**2**
WT. AVG	3	3	2.25	3	2	-					2	3	2.25	1.5
Overall Mapping of Subject														2.25

List of experiments:

Perform any 10 Experiments:-

1. Verify principle of Superposition theorem with dc and ac sources.
2. Verify Thevenin's and Norton's theorems in ac circuits.
3. Verify Maximum Power Transfer theorem in ac circuits.
4. To study the Transient response of RC, RL circuit
5. To study the resonance frequency, Band width of RLC series circuit
6. To plot the frequency response of low pass filter and determine half-power frequency.
7. To plot the frequency response of high pass filters and determines the half-power frequency.
8. To plot the frequency response of band-pass filters and determines the band-width.
9. To calculate and verify "Z" & "Y" parameters of a two port network.
10. To determine equivalent parameter of parallel connections of two port network and study loading effect.
11. To calculate and verify "ABCD" parameters of a two port network.
12. To synthesize a network of a given network function and verify its response.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S.N	Experiment Name	Experiment Link(s)
1		https://www.vlab.co.in/broad-area-electrical-engineering
2		https://ee-iitr.vlabs.ac.in/
3		https://vlabs.iitkgp.ac.in/
4		https://www.circuitlab.com

ENVIRONMENTAL SCIENCE		
Course Code	**26AU-ENV-202-H**	**External marks: 70**
Credits	**0**	**Internal marks: 30**
L-T-P	**2-0-1**	**Total marks: 100**
		Duration of Examination: 3 hrs

COURSE OBJECTIVES:

- People working in industries or elsewhere essentially require the knowledge of environmental science so as to enable them to work and produce most efficient, economical and eco-friendly finished product. It will guide the students living in a historic transitional period of burgeoning awareness of the conflict between human activities and environmental constraints to help and save the fragile and endangered planet with the natural resources already overexploited

COURSE OUTCOMES (CO):

By the end of the Course, Students will be able to:

CO1: Solve various engineering problems applying environmentally sustainable approach to produce eco-friendly products.

CO2: Use relevant pollution control methods to solve domestic and industrial problems.

CO3: To recognize eco-friendly and sustainable energy resources for combating global problems like climate change, acid rain and resource depletion etc.

CO4: To solve local solid hazardous and e-waste problems.

CO - PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2									
CO2		3									
CO3	2	3									
CO4			3								

26MC-106H: (ENVIRONMENTALSCIENCE)

Theory 70Marks FieldWork 30Marks (Practical/Field visit)

Unit-1 TheMultidisciplinarynatureofenvironmentalstudies.Definition, scopeandimportance. Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere. Interaction between earth, man and environment.

(2lectures)

Unit-2NaturalResources:

Renewableandnon-renewableresources:

Naturalresourcesandassociatedproblems.

a) Forest resources:Useandover-exploitation;deforestation, casestudies.Timberextraction,miningdamsandtheireffects onforestsandtribalpeople.

b) Waterresources:Useandover-utilizationofsurfaceand groundwater,floods,drought,conflictsoverwater,dams- benefitsandproblems.

c) Mineralresources:Useandexploitation,environmentaleffects ofextractingandusingmineralresources,casestudies.

d) Foodresources: World foodproblems,changes,causedby agricultureandovergrazing,effectsofmodernagriculture, fertilizer-pesticideproblems,Waterlogging,salinity,case studies.

e) Energyresources:Growingenergyneeds;renewableandnon-renewableenergysource,useofalternatesources,case studies.

f) Landresources:Landasaresource,landdegradation,maninducedlandslides,soilerosionanddesertification.

* Roleofanindividualinconservationofnaturalresources.

* Equitableuseofresourcesforsustainablelifestyles.

(5lectures)

Unit-3 Ecosystem and biodiversity conservation

* Structure of ecosystem, Biotic and Abiotic components

* Energyflowintheecosystem.

* Ecologicalsuccession.

* Foodchains,foodwebsandecologicalpyramids.

* Aquatic and terrestrial ecosystems

* Different level of biodiversity:Genetic,Speciesandecosystemdiversity.

* Valueofbiodiversity:consumptiveuse,productiveuse, social,ethical,aestheticandoptionvalues.
* Biodiversityatglobal,Nationalandlocallevels.
* Indiaasamega-diversitynation.
* Hot-spotsofbiodiversity.
* Threatstobiodiversity:habitatloss,poachingofwildlife, man-wildlifeconflicts.
* EndangeredandendemicspeciesofIndia.
* Conservationofbiodiversity:In-situandex-situ conservationofbiodiversity.

(5 lecture)

Unit-4 Environmental Assessment and Management:

Aims and objectives of environmental impact assessment (EIA), Environmental Impact Statement (EIS) and environment management plan (EMP). Structure and role of central and state pollution control board, ISO14000: implementation in industries benefit.

* EnvironmentProtectionAct.
* Air(PreventionandControlofpollution)Act.
* Water(PreventionandControlofpollution)Act.
* WildlifeProtectionAct.
* ForestConservationAct.
* Issuesinvolvedinenforcementofenvironmentallegislation.
* Publicawareness.

(3 lectures)

Unit-5 Environmentalpollution:

Definition,causes,effectsandcontrolmeasuresof:

a) Airpollution.

b) Waterpollution c) Soilpollution

d) Marinepollution e) Noisepollution

f) Thermalpollution g) Nuclearhazards

* Bag filters, cyclone separator, electrostatic precipitator, catalytic converter.

* Roleofanindividualinpreventionofpollution.

* Pollutioncasestudies.

* Disastermanagement:floods,earthquake,cycloneand landslides.

(5lectures)

Unit-6 Contemporary environmental issues:

* Fromunsustainabletosustainabledevelopment.

* Urbanproblemsrelatedtoenergy, National solar mission.

* Waterconservation,rainwaterharvesting, watershed management, NamamiGange and Yamuna action plan.

* Resettlementandrehabilitationofpeople:itsproblems andconcernscasestudies.

* Environmentalethics:Issuesandpossiblesolutions.

* Climatechange,globalwarming,acidrain,ozonelayerdepletion, sea level rise,nuclearaccidentsandholocaust.Casestudies.

* Wastelandreclamation.

* Carbon sequestration and carbon credits, carbon foot print

* Waste management- Swachha Bharat Abhiyan

* Consumerismandwasteproducts.

(5 lectures)

Unit-7 HumanpopulationandtheEnvironment. Populationgrowth,variationamongnations.Populationexplosion-FamilyWelfareProgramme. Environmentandhumanhealth. Epidemiological issues: Fluorosis, Arsenocosis, Goitre, Dengue. HumanRights, ValueEducation, HIV/AIDS. WomanandChildWelfare. RoleofInformationTechnologyinEnvironmentandhuman health. CaseStudies. (5 lectures)

Unit-8 FieldWork:

* Visittoalocalareatodocumentenvironmentalassets- river/forest/grassland/hill/mountain.

* Visittoalocalpollutedsite-urban/Rural/Industrial/ Agricultural.

* Study of water polluted site

* Studyofcommonplants,insects,birds.

* Studyofsimpleecosystems-pond,river,hillslopes,etc.

(Fieldworkequalto15 lecturehours).

Suggested Text Books / Reference Books:

1. Agarwal,K.C.2001EnvironmentalBiology,NidiPub.Ltd.
   Bikaner.
2. Bharucha,Frach,TheBiodiversityofIndia,MApinPublishingPvt.Ltd.Ahmedabad-380013,India,E-mail:mapin@icenet.net(R).
3. BrunnerR.C.1989,HazardousWasteIncineration,Mc.Graw
   HillInc.480p.
4. ClarkR.S.,Marinepollution,SlandersonPressOxford(TB).
5. Cunningham,W.P.Cooper,T.H.Gorhani,E&Hepworth,M.T.
   2001,EnvironmentalEncyclopedia,JaicoPub.House,Mumbai
   1196p.
6. DeA.K.,EnvironmentalChemistry,WileyEasternLtd.
7. DowntoEarth,CentreforScienceandEnvironment(R).
8. Gleick,H.P.,1993.Waterincrisis,PacificInstituteforStudiesinDev.Environment&SecurityStockholm Env.Institute, OxfordUniv.Press,473p.
9. HawkinsR.E.EncyclopediaofIndianNaturalHistory,Bombay
   NaturalHistorySociety,Bombay(R).
10. Heywood,V.H.&Watson,R.T.1995. Global Biodiversity
    Assessment,CambridgeUni.Press1140p.
11. Jadhav,H&Bhosale,V.M.1995.EnvironmentalProtection andLaws.HimalayaPub.House,Delhi284p.
12. Mackinney,M.L.&Schoch,RM1996,EnvironmentalSciencesystems&solutions,Webenhancededition. 639p.
13. MhaskarA.K., MayyerHazardous,Tekchno-Science

Publications(TB).

14. MillerT.G.Jr.EnvironmentalScience,Wads worthPublishing Co. TB).

15. Odum,E.P.1971,FundamentalsofEcology.W.B.Saunders Co.USA,574p.

16. RaoM.N.&Datta,A.K.1987WasteWaterTreatment.Oxford &TBHPubl.Co.Pvt.Ltd.345p.

17. Sharma,B.K.2001,EnvironmentalChemistry,GoalPubl. House,Meerut.

18. SurveyoftheEnvironment,TheHindu(M).

19. TownsendC.,HarperJ.andMichaelBegon.Essentialsof Ecology,BlackwellScience(TB).

20. TrivediR.K.,HandbookofEnvironmentalLaws,Rules, Guidelines,ComliancesandStandards,Vol.IandIIEnviroMedia(R).

21. TrideviR.K.andP.K.Goal,Introductiontoairpollution,Techno SciencePublications(TR).

22. WagnerK.D.,1998,EnvironmentalManagement,W.B. Saundersco.Philadelphia,USA499p.

23. AtextbookenvironmentaleducationG.V.S.PublishersbyDr. J.P.Yadav.

(M) Magazine (R) Reference (TB)extbook

Theschemeofthepaperwillbe asunder:

ThesubjectofEnvironmental Sciencewill beincludedasa qualifyingpaperinallUGCoursesandthestudentswillberequiredtoqualifythesame.Thedurationofthecoursewil lbe45lectures.The examinationwillbeconductedalong withthesemesterexaminations.

Exam.Pattern:Incaseofawardingthemarks,thepaperwill carry100marks.

Theory:70 marks,Practical/ Field visit:30marks.

Thestructure ofthequestionpaperwillbe:

Part-A:ShortAnswerPattern : 10marks

Part-B:EssayTypewithinbuiltchoice : 60marks

Part-C:

FieldWork(Practical) : 30marks

InstructionsforExaminers:

Part-A:QuestionNo.1iscompulsoryandwillcontainfiveshort- answertypequestionsof2 markseachcoveringtheentiresyllabus.

Part-B:Eightessaytypequestions(withinbuiltchoice)willbeset fromtheentiresyllabusandthecandidatewillberequiredtoanswer anyfourofthem.Eachessaytypequestionwillbeof15marks.

Theexaminationoftheregularstudentswillbeconductedbytheconcernedcollege/Institute.Each studentwillberequiredtoscoreminimum40%marksseparatelyin theoryandpractical/Field visit.Themarks inthisqualifyingpaperwillnotbe includedindeterminingthepercentageofmarksobtainedfortheaward ofdegree.However,thesemarkswillbeshowninthedetailedmarks certificateofthestudents.

Course code	26PCC-ECE-215-H				
Category	Program Core Course& Program Elective Course				
Course title	**Electronic Measurement and Instrumentation**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester-III**
	3	0	0	3	
Classwork	25 Marks				
Examination	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Objectives:

1. To familiarize the student with the principal of operation, analysis and design electronic instruments.
2. To understand working and block diagram of oscilloscope.
3. To study basic principal of signal conditioning and signal genrators.

COURSE OUTCOMES (CO):

By the end of the Course, Students will be able to:

CO1: Understand the principles of electronic measuring instruments.

CO2: Understand generation and analysis of waveforms.

CO3: Understand transducers and signal conditioning.

CO4: Understand the functioning of oscilloscope.

CO - PO mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	2		1	2				1		1	**2**	**2**	**2**
CO2	3	3	2	2	3				1		1	**3**	**3**	**1**
CO3	3	2	2	2	3	1			1		1	**3**	**3**	**2**
CO4	3	2	1	2	3				1		1	**2**	**2**	**2**
WT. AVG	3	2.25	1.67	1.75	2.75	1			1		1	2.5	2.5	1.75
Overall Mapping of Subject														2.25

Note: The examiner will set a total of 9 questions. Question one will carry questions from all units, and the remaining eight questions will be set by taking two questions from each unit. The students have to attempt five questions in total, with the first being compulsory and selecting one from each unit. All questions will carry equal marks.

UNIT-I

OSCILLOSCOPE: Block diagram, study of various stages in brief, high frequency CRO considerations measurement of phase &frequency,electrostaticdeflection,dual trace &dual beam oscilloscope Sampling and storage oscilloscope.

UNIT-II

ELECTRONIC INSTRUMENTS: Instruments for measurement of voltage, current & other circuit parameters, Q-meters, R.F. power measurements, introduction to digital meter,chopper amplifier type voltmeter,true RMS voltmeter,electronicmultimeter

UNIT-III

GENERATION & ANALYSIS OF WAVEFORMS: Block diagram of pulse generators, signal generators, function generators wave analysers, distortion analysers, spectrum analyser, Harmonic analyser, FFT analyser FREQUENCY & TIME MEASUREMENT: Study of decade counting Assembly(DCA), frequency measurements, period measurements, universal counter,

UNIT-IV

TRANSDUCERS & SIGNAL CONDITIONING: Classification, Transducers of types: RLC photocell, thermocouples etc. basic schemes of measurement of displacement, velocity, acceleration, strain, pressure, liquid level & temperature. DC signal conditioning system, AC signal conditioning system, data acquisition and conversion system

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Measurement and Instrumentation	Prof.Ravindra Kumar Jha	IIT Guwahati

2	Electrical Measurement and Electronic Instruments	Avishek Chatterjee	IIT Kharagpur

TEXT BOOK:

A course in Electrical & Electronics Measurements &Instrumentation :A.K.Sawhney; Dhanpat Rai & Sons.

REFERENCE BOOKS:

Electronics Instrumentation & Measurement Techniques : Cooper; PHI.

Course code	26LC-ECE-217-H				
Category	Program Core Course				
Course title	**Electronic Measurement and Instrumentation Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester-III
	0	**0**	**2**	**1**	
Internal Lab	05 Marks				
External lab	20 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

Course Objective

To impart the practical knowledge of basic electronic measurement and instrumentation.

Course Outcomes

CO1: To teach the students basic fundamentals of oscilloscope.
CO2: To experimentally analyze different type of transducers and different measuring instruments.
CO3: To experimentally teach the students the concept of signal conditioning.
CO4: To teach the students how to generate different waveforms.

CO - PO mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	2	2		3	3				2		1	**2**	**3**	**1**
CO2	2	3	2	3	3	1			2		1	**3**	**3**	**1**
CO3	2	2	3	3	3	1			2		1	**3**	**3**	**1**
CO4	3	3	2	3	3			2	2		1	**3**	**2**	**2**
WT. AVG	2.25	2.5	2.33	3	3	1		2	2		1	2.75	2.75	1.25
Overall Mapping of Subject														2.25

List of experiments:

Hands on experiments related to the course contents of ELECTRONIC MEASUREMENT AND INSTRUMENTATION

Introduction To Machine Learning

Course code	26PCC-AIML-222-H				
Category	Professional Core Courses				
Course title	**Introduction to Machine Learning**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester-III/IV
	3	**0**	**0**	**3**	
Classwork	25 Marks				
Examination	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

COURSE OBJECTIVES:

1. To introduce the foundational concepts, history, and lifecycle of machine learning, along with its various classifications and real-world applications.
2. To understand mathematical data representation, data preprocessing techniques, and apply dimensionality reduction methods like Principal Component Analysis (PCA).
3. To explore and implement core supervised learning algorithms, including decision trees, Naive Bayes, regression models, and Support Vector Machines (SVM).
4. To examine unsupervised clustering methods, ensemble learning techniques, and rigorously evaluate model performance using advanced metrics like ROC-AUC and confusion matrices.

COURSE OUTCOMES (CO):

By the end of the Course, Students will be able to:

CO1: Understand the fundamental issues, challenges, and core paradigms of supervised, unsupervised, and reinforcement learning techniques.
CO2: Apply mathematical data representations and feature extraction/preprocessing techniques suitable for a particular machine learning approach.
CO3: Analyze and compare the pros and cons of various machine learning algorithms to gain insight into when to apply a specific approach to solve a problem.
CO4: Evaluate and mathematically analyze machine learning models using appropriate performance measurement metrics and statistical distributions.

CO - PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	1	1	2	-	-	-	-	-	2
CO2	3	3	2	1	3	-	-	1	-	-	2
CO3	3	3	3	2	3	-	-	1	1	-	2
CO4	3	3	2	3	3	-	-	1	1	-	2

UNIT-I

Introduction: Machine Learning: Definition, History, Need, Features, Block diagrammatic representation of learning machines, Machine Learning life cycle, Applications of Machine Learning. What are datasets, and how to handle them? Feature sets, Dataset division: test, train and validation sets, cross-validation, Sources of dataset

UNIT-II

Introduction to Machine Learning Techniques: Supervised Learning, Unsupervised Learning and Reinforcement Learning, Extended & Hybrid Learning Paradigms: Transfer Learning, Ensemble Learning, Transfer Learning, Real-life examples of Machine Learning.

UNIT-III

Supervised Learning: Definition and How It Works. Types of Supervised learning algorithms: k-Nearest Neighbours, Linear Regression, Logistic Regression, and Support Vector Machines. Evaluation Measures of regression: Absolute error, MSE, RMSE, SSE, MME, R2, Median absolute deviation (MAD), Distribution of errors.

UNIT-IV

Unsupervised Learning: Clustering: Introduction to clustering, Types of Clustering: Hierarchical, Agglomerative Clustering and Divisive clustering; Partitional Clustering: K-means. Evaluation: Performance measurement of models in terms of accuracy, confusion matrix, precision & recall, F1-score, receiver Operating Characteristic Curve (ROC) curve and AUC

Suggested Books:

1. E. Alpaydin, Introduction to Machine Learning, Prentice Hall of India, 2006. (Note: Combined lines 1 & 2 from your prompt for accurate formatting).
2. T Hastie, R Tibshirani and J Friedman, The Elements of Statistical Learning Data Mining, Inference, and Prediction, 2nd Edition, Springer, 2009.
3. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2010.

Alternative NPTEL/SWAYAM Course:

SNo	NEPTEL course name	Instructor	Host Institute
1.	Introduction to Machine Learning	Prof. BalaramanRavindran	IIT Madras
2	Introduction to Machine Learning	Prof. Sudeshna Sarkar	IIT Kharagpur

Course code	26PEC-ECE-219-H				
Category	Program Elective courses (PEC)				
Course title	**Probability and Stochastic Processes**				
Scheme and Credits	L	T	P	**Credits**	Semester-III
	2	1	0	3	
Class work	25 Marks				
Exam	50 Marks				

Total	75 Marks
Duration of Exam	03 Hours

Course Objectives:

1. Develop a fundamental understanding of probability theory and random variables.
2. Study discrete and continuous probability distributions and their properties.
3. Introduce stochastic processes with emphasis on Markov chains and related models.
4. Analyze random walk, Brownian motion, and continuous-time Markov processes.

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1. Explain probability space, conditional probability, Bayes theorem, and analyze discrete random variables with standard probability distributions (Bernoulli, Binomial, Poisson), including expectation, variance, and Chebyshev inequality.

CO2. Apply properties of continuous random variables and compute probabilities using normal, exponential, and gamma distributions; analyze bivariate distributions and conditional densities.

CO3. Analyze stochastic processes and discrete-time Markov chains, including transition probability matrices, Chapman–Kolmogorov equations, and classification of states.

CO4. Apply concepts of random walk, Brownian motion, Poisson processes, and continuous-time Markov chains including birth–death processes.

CO-PO Mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	1	2							1	**2**	**3**	**2**
CO2	3	3	1	2							1	**2**	**3**	**2**
CO3	3	3	2	3							1	**3**	**2**	**1**
CO4	3	3	2	2							1	**3**	**2**	**1**
WT. AVG	3	3	1.5	2.25							1	2.5	2.5	1.5
Overall Mapping of Subject														2.16

Note: The examiner will set a total of 9 questions. Question one will carry questions from all units, and the remaining eight questions will be set by taking two questions from each unit. The students have to attempt five questions in total, with the first being compulsory and selecting one from each unit. All questions will carry equal marks.

UNIT I

Probability space; Conditional probability and Bayes theorem; Discrete random variables, probability mass function, probability distribution function, Bernoulli,Binomial, Poisson Probability Distribution. Expectation and Variance of Discrete Random Variables, Chebyshev inequality.

UNIT II

Continuous random variables and their properties, distribution functions and densities, normal,exponential and gamma densities.Bivariate distributions and their properties, conditional densities**.**

UNIT III

Stochastic Processes: Definition and examples of stochastic processes, Classifications of stochastic processes, Markov chains: Definition and examples, Transition Probability matrices, Chapman-Kolmogorov equations,Reducible Markov chains.

UNIT IV

Random Walk and Brownian motion. Markov chains in continuous time: Stationary processes. Poisson processes. General pure birth and death processes.

References:

1. H. Stark and J. Woods, ``Probability and Random Processes with Applications to Signal Processing," Third Edition, Pearson Education

2. A. Papoulis and S. Unnikrishnan Pillai, ``Probability, Random Variables and Stochastic Processes," Fourth Edition, McGraw Hill.

3.J. Mendhi, Stochastic Process, New Age International, 3rd edition, 2009.

4. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Stochastic Processes, UBS Publishers

5. S. Ross, Introduction to Stochastic Models, Harcourt Asia, Academic Press.

Course code	26PEC-EE-206-H				
Category	Programme Elective Course				
Course title	**Soft Computing (Theory)**				
Scheme and Credits	L	T	P	Credits	Semester-4
	3	1	0	4	
Classwork	30Marks				
Examination	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

To understand the concepts of soft computing.

- To introduce the ideas of fuzzy logic, Artificial Neural networks, genetic algorithm.
- To introduce the concepts of hybrid intelligent systems.

- To introduce application areas of soft computing and the criteria to select appropriate soft computing

Course Outcomes: At the end of this course, students will demonstrate the ability to

CO1: Understand the concepts and basics of soft computing.

CO2: Know about the basic soft computing techniques like of fuzzy logic, Artificial Neural networks, genetic algorithm etc..

CO3: Understand the basic concepts, advantages and disadvantages of hybrid intelligent systems.

CO4: Various areas where soft computing and related techniques can be practically implemented.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2									2	2		
CO2	2	3	2	2	2						2	3	2	
CO3	2	3	2	2	2						2	3	2	2
CO4	2	3	3	2	2						2	3	2	2
WT. AVG	2	2.75	2.5	2	2						2	3	2	2
Overall Mapping of Subject														2.5

Section A

Soft Computing: Introduction, requirement, different soft computing techniques and their characteristics, comparison with hard computing, applications.

Section B

Fuzzy sets and Fuzzy logic: Introduction, Fuzzy sets versus crisp sets, properties of fuzzy sets, operations on fuzzy sets, Extension principle, Fuzzy relations, Linguistic variables, linguistic terms, Linguistic hedges, Fuzzy reasoning, Mamdani and TSK fuzzy inference systems, Applications, fuzzy controllers, Theoretical and implementation issues.

Section C

Artificial Neural Network: Introduction, comparison with biological neural network, basic models of artificial neuron, different architectures of ANN, Learning techniques, ANN based system modeling, ANN based controller design, theoretical and implementation issues, Applications.

Section D

Evolutionary algorithms and hybrid systems: Genetic Algorithm (GA), different operators of GA, convergence of Genetic Algorithm, Particle swarm optimization algorithm, Neural-Network-Based Fuzzy Systems, Fuzzy Logic-Based Neural Networks, Genetic Algorithm for Neural Network Design, Fuzzy Logic design, other Applications of GA.

References :

1. Neuro Fuzzy & Soft Computing - J.-S.R.Jang, C.-T.Sun, E.mizutani, Pearson Education

2. Neural Networks and Fuzzy Systems: Dynamical Systems Application to Machine Intelligence - Bart Kosko, Prentice Hall

3. T.J. Ross, "Fuzzy Logic Control", TMH Publications.

4. S. Hekins, "Comprehensive Neural Networks", Pearson Publications.

5. S. Rajsekharan, VijayalaxmiPai, "Neural Networks, Fuzzy logic and Genetic Algorithms, Synthesis and applications", Prentice Hall

6. V. Kecman, "Learning and Soft Computing", MIT Press. B.Tech. (Electrical Engineering) BOS 24-05-2017

7. D. Ruan, "Intelligent Hybrid Systems", Kluwer Academic Publisher.

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Course code	26PCC-ECE-202-H				
Category	Program Core Course				
Course title	**Analog Circuits**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester-IV**
	3	1	0	4	
Classwork	30 Marks				
Examination	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Objectives:

1. **Understand** the high-frequency models of transistors and analyze the frequency response of single-stage and multistage amplifiers, including cascode configurations.
2. **Explain and evaluate** different classes of power amplifier operation (Class A, B, AB, C) in terms of efficiency, linearity, and practical applications.
3. **Apply feedback theory** to electronic amplifiers and analyze the effect of feedback on gain, bandwidth, and stability.
4. **Design and analyze** oscillators, and differential amplifiers for specified performance requirements.

COURSE OUTCOMES (CO):

By the end of the Course, Students will be able to:

CO1: Understand high-frequency transistor models and analyze frequency response of single-stage and multistage amplifiers including cascode configuration.

CO2: Analyze different classes of operation of power amplifiers and evaluate their efficiency and linearity.

CO3: Apply feedback theory to amplifier circuits and analyze stability parameters

CO4: Design and analyze oscillators, and differential amplifier circuits.

CO - PO mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2	2	-	-	-	-	-	2	3	2	1
CO2	3	3	2	1	1	-	-	-	-	-	2	3	2	1
CO3	3	3	3	2	2	-	-	-	-	-	2	3	3	1
CO4	3	3	3	2	2	-	-	-	-	-	2	3	3	2
WT. AVG	3	3	2.5	1.75	1.75						2	3	2.5	1.25
Overall Mapping of Subject														2.25

Note: The examiner will set a total of 9 questions. Question one will carry questions from all units, and the remaining eight questions will be set by taking two questions from each unit. The students have to attempt five questions in total, with the first being compulsory and selecting one from each unit. All questions will carry equal marks.

UNIT I

Amplifier models: Amplifier models: Voltage amplifier, current amplifier, trans-conductance amplifier and trans-resistance amplifier. Small signal analysis of BJT, low frequency transistor models, estimation of voltage gain, input resistance, output resistance etc., design procedure for particular specifications, low frequency analysis of multistage amplifiers. High frequency transistor models, frequency response of single stage and multistage amplifiers, cascode amplifier.

UNIT II

Feedback Amplifiers: Feedback concept, Transfer Gain with Feedback, General Characteristics of Negative Feedback, Advantages & disadvantages, Input And Output Resistance, Voltage Series Feedback topology, Voltage Shunt, Current Series & Current Shunt topology ,Equivalent circuit for each topology, Effects of Negative Feedback.

Oscillators: Introduction, Barkhausen Criterion, Oscillator with RC Feedback circuit (RC Phase Shift, Wien Bridge), Tuned Collector, Tuned Base Oscillator, LC Feedback circuits (Hartley, Colpitts), Condition for Sustained Oscillations & Frequency of Oscillations, Crystal Oscillator.

UNIT III

Power Amplifier: Definition, Application & Types of Power Amplifiers, Amplifier Classes of Efficiency (Class - A, B, AB, C), Push Pull Amplifiers, Distortion in Simple & Push Pull Amplifier, Complementary Push Pull Amplifier,

Operational Amplifier Fundamentals:Block Diagram Representation, Ideal OP-AMP, OP-AMP Equivalent Circuit, characteristics, Differential amplifier: Basic structure and principle of operation, calculation of differential gain, common mode gain, CMRR and ICMR.

UNIT IV

OP-AMP applications: review of inverting and non-inverting amplifiers, integrator and differentiator, summing amplifier, precision rectifier, Schmitt trigger and its applications. Active filters: Low pass, high pass, band pass and band stop, design guidelines. Digital-to-analog converters (DAC): Weighted resistor, R-2R ladder, resistor string etc. Analog-to-digital converters (ADC): Single slope, dual slope, successive approximation, flash etc.:
555 timer: operation as astable and monostable multivibrator.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Analog Electronics Circuits	Prof.Pradip Mandal	IIT Kharagpur
2	Analog Electronics Circuits	Prof.ShanthiPavan	IITMadras

Text/ Reference Books

1. A.V.N. Tilak, Design of Analog Circuits, Khanna Publishing House, 2022.

2. J.V. Wait, L.P. Huelsman and GA Korn, Introduction to Operational Amplifier theory and applications, McGraw Hill, 1992.

3. P. Horowitz and W. Hill, The Art of Electronics, 2nd edition, Cambridge University Press, 1989.

4. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Saunder's College Publishing, Edition IV

5. Paul R.Gray& Robert G.Meyer, Analysis and Design of Analog Integrated Circuits, John Wiley, 3rd Edition

Course code	26PCC-ECE-204-H				
Category	Program Core Course				
Course title	**Microprocessors and Interfacing**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester-IV**
	3	1	0	4	
Classwork	30 Marks				
Examination	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Objectives:

1. To make understand architecture and working of Intel 8085 microprocessor in depth.
2. To make understand architecture and working of Intel 8086 microprocessor in depth.
3. Familiarization with the assembly language programming.
4. Familiarization with various peripheral operations.

COURSE OUTCOMES (CO):

By the end of the Course, Students will be able to:

CO1: Understand the operation and architecture of Intel 8085 microprocessor including Instruction Set Architecture, assembly language programming, timing and speed of operation.

CO2: Learn the operation of circuits for user interaction through switches, keyboard and display devices.

CO3: Understand the operation and architecture of Intel 8086 microprocessor including Instruction Set Architecture, assembly language programming, timing and speed ofoperation.

CO4: Understand the motivation and need for peripheral operations circuits for digital data exchange, timer, serial communication, merits of direct memory access, interrupt controller and other circuits.

CO - PO mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	2	-	-	-	-	-	2	3	2	1
CO2	3	2	2	2	3	-	-	1	1	-	2	3	3	1
CO3	3	3	2	2	2	-	-	1	1	-	2	3	3	1
CO4	3	3	3	2	3	1	-	1	1	-	3	3	3	2
WT. AVG	3	2.5	2	1.75	2.5	1		1	1		2.25	3	2.75	1.25
Overall Mapping of Subject														2.33

Note: The examiner will set a total of 9 questions. Question one will carry questions from all units, and the remaining eight questions will be set by taking two questions from each unit. The students have to attempt five questions in total, with the first being compulsory and selecting one from each unit. All questions will carry equal marks.

UNIT I

THE 8085 PROCESSOR: Introduction to microprocessor, 8085 microprocessor: Architecture,instruction set, interrupt structure, and Assembly language programming.

UNIT II

THE 8086 MICROPROCESSOR ARCHITECTURE: Architecture, block diagram of 8086, detailsof sub-blocks such as EU, BIU; memory segmentation and physical address computations,program relocation, addressing modes, instruction formats, pin diagram and description ofvarious signals

UNIT III

INSTRUCTION SET OF 8086: Instruction execution timing, assembler instruction format, datatransfer instructions, arithmetic instructions, branch instructions, looping instructions, NOPand HLT instructions, flag manipulation instructions, logical instructions, shift and rotate instructions, directives and operators, programming examples.

Unit IV

INTERFACING DEVICE:8255 Programmable peripheral interface, 8254 (8253) programmable interval timer, 8259A programmableinterrupt controller, and 8237 DMA controller.Interfacing with Memory, Interfacing with A/D and D/A converter. Introduction to advance processors and programming model of X86 family.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Microprocessors and Microcontrollers	Prof.IndranilSengupta	IIT Kharagpur
2	Computer Architecture and Organization	Prof.Smruti R. Sarangi	IIT Delhi

TEXT BOOKS:

1. Microprocessor Architecture, Programming & Applications with 8085: Ramesh S Gaonkar; Wiley Eastern Ltd.
2. Intel Microprocessors 8086- Pentium processor: Brey; PHI

REFERENCE BOOKS:

1. Microprocessors and interfacing: D V Hall; TMH
2. The 8088 & 8086 Microprocessors-Programming, interfacing, Hardware & Applications: Triebel& Singh; PHI
3. Microcomputer systems: the 8086/8088 Family: architecture, Programming &Design: Yu-Chang Liu & Glenn A Gibson; PHI.
4. Advanced Microprocessors and Interfacing: Badri Ram; TMH

Course code	26PCC-ECE-206-H				
Category	Program Core Course				
Course title	**Digital Electronics**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester-IV**
	3	0	0	3	
Classwork	25 Marks				
Examination	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Objectives:

CO1: To introduce fundamental concepts of digital systems, number systems, codes, and logic representations.

CO2: To develop skills for designing and analyzing combinational logic circuits, including simplification and synthesis techniques.

CO3: To understand various logic families, their characteristics, and practical implications in digital design.

CO4: To impart knowledge of sequential circuits, state machine design, FPGAs and ASICs.

COURSE OUTCOMES (CO):

After completing this course, the student will be able to:

CO1	Understand number systems, number representation, binary codes and error detection methods.
CO2	Analyze and simplify Boolean expressions using K-Map, Quine–McCluskey and design various combinational logic circuits.
CO3	Explain properties of different logic families such as TTL, CMOS, ECL and their performance metrics.
CO4	Design, analyze and implement sequential circuits using latches, flip-flops ,state machines, Memories ,FPGAs and ASICs

CO - PO mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	–	–	–	–	–	–	–	–	2	2	1	2
CO2	3	3	2	–	–	–	–	–	–	–	2	3	2	2
CO3	2	3	3	–	2	–	–	–	–	–	2	3	3	2
CO4	2	2	–	–	3	–	–	–	–	–	2	2	2	2
WT. AVG	2.5	2.5	1.25		1.25							2.5	2	2
Overall Mapping of Subject														2.16

Note: The examiner will set a total of 9 questions. Question one will carry questions from all units, and the remaining eight questions will be set by taking two questions from each unit. The students have to attempt five questions in total, with the first being compulsory and selecting one from each unit. All questions will carry equal marks.

UNIT I

Introduction to Digital Techniques: Digital Systems; Logic circuits, Analysis, design and implementation of digital systems, Number Systems and Codes-; Binary, octal and hexadecimal number systems; Methods of base conversions; Binary, octal and hexadecimal arithmetic; Representation of signed numbers; Fixed and floating point numbers; Binary codes: BCD codes, Excess-3, Gray codes; Error detection and correction codes -parity check codes and Hamming code, Canonical and standard forms, POS and SOP simplifications, K-Map method, Q-M method, don't care conditions

UNIT II

Logic families: Introduction to different logic families; such as RTL, TTL, ECL, and CMOS with their characteristics including propagation delay, power dissipation, fan-in, fan-out, and noise margin.

Combinational design using MST devices: Encoders, Decoders, multiplexers, Demultiplexer and their use as logic elements; Parity circuits and comparators; Arithmetic modules- adders, subtractors , BCD arithmetic circuits

UNIT III

Sequential circuits: Definition of state machines, state machine as a sequential controller; Basic sequential circuits- latches and flip-flops: SR-latch, D-latch, D flip-flop, JK flip-flop, T flip-flop; Timing hazards and races ;Analysis of state machines using D flip-flops and JK flip-flops; Design of state machines - state table, state assignment, transition/excitation table,

Unit IV

State machine design: Designing state machine using ASM charts, Designing state machine using state diagram, Design of registers, counters-asynchronous and synchronous, up/down counter, Ring and Johnson counters.

Memory – Organization, Functional Diagram, Memory operations, Classification of semiconductor memories, Read and Write Memories, ROM ,Programmable Logic Devices-PLAs, PALs and their applications, Generic Array logic devices, Sequential PLDs and their applications; Introduction to field programmable gate arrays (FPGAs) and ASICS

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Digital Circuits	**Prof.Santanu Chattopadhyay**	IIT Kharagpur **NPTEL**
2	Digital Electronics	**Dr. P. Sivasankar**	**NITTTR Chennai**, SWAYAM

TextBooks:

1. G.K .Kharate: Digital Electronics,1st edition,Oxford university press,2010

ReferenceBooks:

1. M .M. ManoandM.D.Ciletti:Digital design 4th edition, PrinteceHall.2006
2. R.P .Jain:Modern Digital Electronics, 3rd edition,TMH.2003
3. .A.A.Kumar:Fundamentals of digital circuits,2nd edition,Printece Hall of India
4. A.P.MalvinoandD.P.Leach:Digital principle and applications, 6th edition,TMH,2008
5. Z.Kohavi ,Switching and FiniteAutomataTheory,Mc GrawHill,1970.

Course code	26PCC-ECE-208-H				
Category	Program Core Course				
Course title	**Electromagnetic Waves**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester-IV**
	3	1	0	4	
Classwork	30 Marks				
Examination	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Objectives

The objectives of this course are to:

1. **To understand** the fundamentals of transmission lines and electromagnetic field theory using Maxwell's equations.
2. **To explain** the propagation of electromagnetic waves in free space and material media, including reflection, refraction, and polarization phenomena.
3. **To analyze** wave propagation characteristics in guiding structures such as waveguides and transmission lines.
4. **To study** radiation mechanisms and antenna characteristics for effective transmission and reception of electromagnetic energy.

COURSE OUTCOMES (CO):

By the end of the Course, Students will be able to:
CO1: Analyze transmission line behavior using voltage–current relations, impedance matching techniques, and Smith Chart.
CO2: Apply Maxwell's equations to derive wave equations and evaluate power flow using the Poynting vector.
CO3: Explain plane wave propagation, reflection, refraction, polarization, and wave behavior in conducting and dielectric media.
CO4: Analyze waveguides and antenna radiation characteristics, including radiation parameters of dipole and monopole antennas.

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2	2	-	-	-	-	-	2	3	2	1
CO2	3	3	2	3	2	-	-	-	-	-	2	3	3	1
CO3	3	2	2	2	1	-	-	-	-	-	2	3	2	1
CO4	3	2	3	2	2	-	-	-	-	-	3	3	3	1
WT. AVG	3	2.5	2.25	2.25	1.75						2.25	3	2.5	1
Overall Mapping of Subject														2.16

Note: The examiner will set a total of 9 questions. Question one will carry questions from all units, and the remaining eight questions will be set by taking two questions from each unit. The students have to attempt five questions in total, with the first being compulsory and selecting one from each unit. All questions will carry equal marks.

Unit–I

Transmission Lines: Transmission lines and their classification, equations of voltage and current on transmission lines, propagation constant, characteristic impedance and reflection coefficient, impedance transformation, lossless and low-loss transmission lines, standing waves and voltage standing wave ratio (VSWR), power transfer on transmission lines, Smith Chart and admittance Smith Chart, applications of transmission lines impedance matching techniques using stubs and quarter wave transformer

Unit–II

Maxwell's Equations and Electromagnetic Field Theory: Maxwell's equations in differential and integral forms, physical interpretation of Maxwell's equations, boundary conditions at the interface of dielectric and conducting media, derivation of electromagnetic wave equation, uniform plane wave solution of the wave equation, power flow in electromagnetic fields, Poynting vector and Poynting theorem,

Unit–III

Plane Waves and Wave Propagation: Uniform plane waves in free space and material media, reflection and refraction of plane waves at dielectric and conducting interfaces, Snell's laws and Fresnel coefficients, polarization of electromagnetic waves including linear, circular and elliptical polarization, phase velocity and group velocity, wave propagation in conducting and dielectric media, attenuation and phase constants, skin depth and its physical significance.

Unit–IV

Waveguides and Radiation: Parallel plane waveguide and wave propagation in parallel plane waveguide, general approach for waveguide analysis, rectangular waveguide, modal propagation in rectangular waveguide, field visualization and attenuation in waveguides, Radiation fundamentals, solution of potential functions, radiation from Hertz dipole, power radiated by Hertz dipole, radiation parameters of antennas**Radiation parameters of antennas:** radiation pattern, radiation intensity, beamwidth, directivity, gain, radiation resistance, antenna efficiency.

S. No.	NPTEL/SWAYAM Course Name	Instructor / Host Institute	Direct Link
1	**Electromagnetic Theory (NOC)** – covers EM waves, transmission lines, waveguides & antennas	Prof. Pradeep Kumar K, IIT Kanpur	https://onlinecourses.nptel.ac.in/noc21_ee83/preview (NPTEL Online Courses)
3	**Electromagnetic Waves in Guided and Wireless Media (NOC)** – focused on guided waves, antennas, transmission lines	Various NPTEL instructors	https://nptel.ac.in/courses/108104130 (NPTEL)
4	**Introduction to EM waves and various techniques of communication** – EM waves and practical	Prof. R. K. Shevgaonkar, IIT Bombay	https://nptel.ac.in/courses/117101056 (NPTEL)

S. No.	NPTEL/SWAYAM Course Name	Instructor / Host Institute	Direct Link
	techniques		

Text/Reference Books:

1. **Samuel Y. Liao**, *Microwave Devices and Circuits*, Prentice Hall of India.
2. **Ramesh Garg, R. J. Adams, and I. J. Bhal**, *Electromagnetic Waves and Transmission Lines*, Wiley
3. **C. A. Balanis**, *Antenna Theory: Analysis and Design*, John Wiley & Sons.
4. **John D. Kraus and Daniel A. Fleisch**, *Electromagnetics*, McGraw-Hill Education.
5. **R. L. Yadav**, *Electromagnetic Fields and Waves*, Khanna Book Publishing, 2021.
6. **E. C. Jordan and K. G. Balmain**, *Electromagnetic Waves and Radiating Systems*, Prentice Hall.
7. **William H. Hayt Jr. and John A. Buck**, *Engineering Electromagnetics*, McGraw-Hill Education.
8. **Matthew N. O. Sadiku**, *Elements of Electromagnetics*, Oxford University Press.
9. **K. Shevgaonkar**, *Electromagnetic Waves*, Tata McGraw-Hill, India, 2005.

Course code	26BSC-MATHECE-204-H				
Category	Program core courses (EC)				
Course title	**Numerical Techniques**				
Scheme and Credits	L	T	P	**Credits**	Semester-IV
	3	0	0	3	
Class work	25 Marks				
Exam	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Objectives:

During the duration of the course, students will be made to learn to:

1. Introduce error analysis and study the accuracy and stability of numerical computations.
2. Develop an understanding of numerical methods for solving algebraic, transcendental, and differential equations.
3. Provide hands-on knowledge of iterative methods, interpolation, numerical integration, linear algebraic systems and eigenvalue problems.
4. Understanding the various numerical techniques to analyze the approximate solution of ODE and some specific PDE.

Course Outcomes:

At the end of the course the students will be able to

CO1. Analyze different types of errors in numerical computations and apply appropriate root-finding methods (Bisection, Regula-Falsi, Secant, Newton-Raphson) to solve algebraic and transcendental equations, and evaluate their rate of convergence.

CO2. Construct interpolation polynomials using Lagrange and Newton's divided difference methods, and perform numerical integration using Trapezoidal and Simpson's rules.

CO3. Solve systems of linear equations using direct and iterative methods and compute eigenvalues using the Power method.

CO4. Describe the numerical solutions of ordinary and partial differential equations by various Numerical Methods.

CO-PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1.	3	3	1	2							1
CO2.	3	3	1	2							1
CO3.	3	3	2	1							1
CO4.	3	3	2	2							1

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 5 parts of 2.0 marks each from all units and remaining eight questions of 10 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

UNIT I

Error formulae, Solutionofalgebraic and Transcendentalequations, bisection and secant methods, Regula-false method, Newton-Raphson method, rate of convergence.

UNIT II

Interpolation by polynomials Lagrange and Newton divided difference, Numerical integration, Trapezoidal and Simpson rules.

UNIT III

Solution of a system of linear equations, Gaussian elimination and GaussSeidel methods, partial pivoting,LU factorization, Cholesky's method, Eigenvalue problem, power method.

UNIT IV

Numerical solution of ordinary differential equations, Euler and Runge-Kutta methods, predictor-corrector methods, finite difference methods, numerical solutions of elliptic, parabolic, and hyperbolic partial differential equations.

References:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons
2. K. E. Atkinson, An Introduction to Numerical Analysis (2nd edition), Wiley-India, 1989
3. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers

4. N. P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications
5. P. Kandasamy, K. Thilagavathy, K. Gunavathi, Numerical Methods, S. Chand & Company.
6. S. S. Sastry, Introductory Methods of Numerical Analysis, PHI Learning.
7. C. E. Froberg, Introduction to Numerical Analysis (2nd Edition), Addison-Wesley, 1981.

Data Structures & Algorithms

Course code	26PCC-CSE-201-H				
Category	Professional Core Course				
Course title	**Data Structures & Algorithms**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester III/IV
	3	**0**	**0**	**3**	
Class work	25 Marks				
Exam	50 Marks				
Total	75Marks				
Duration of Exam	03 Hours				

Course Objectives:

1. To impart the basic concepts of data structures and algorithms.
2. To understand concepts about searching and sorting techniques
3. To understand basic concepts about stacks, queues, lists, trees and graphs.
4. To enable them to write algorithms for solving problems with the help of fundamental data structures.

Course Outcomes (CO):

By the end of the Course, Students will be able to:

CO1: Define various types of data structures and the operations that can be implemented on these data structures. Understand the importance of data structures and algorithms in the context of writing efficient programs. (Level 1: Remember and Understand)

CO2: Choose the appropriate data Structure and algorithm for the specific problems. (Apply)

CO3: Compare and evaluate the performance of various data structures and algorithms. (Level 4: Analyze and Evaluate).

CO4: Develop skills to design data structures in problem solving.

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2				-	-	-	-	-	1
CO2	3	2			2	-	-		-	-	2
CO3	3	3				-	-			-	2

CO4	3				2	-	-			-	3

Note: The examiner will set a total of 9 questions. Question one will carry questions from all units, and the remaining eight questions will be set by taking two questions from each unit. The students have to attempt five questions in total, with the first being compulsory and selecting one from each unit. All questions will carry equal marks.

Unit 1:

Introduction: Basic Terminologies: Concept of Data Structures, Choice of right Data Structure. Algorithms, how to design and develop algorithm, Complexity of algorithm. Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Searching: Linear Search and Binary Search and their complexity analysis.

Unit 2:

Stacks and Queues: Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and Evaluation -corresponding algorithms and complexity analysis. Queue and its operations: Algorithms and their complexity analysis, Types of Queues: Simple Queues, Circular Queues, and Priority Queues.

Unit 3:

Linked Lists: Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion, Deletion; Linked representation of Stack and Queue; Header linked list, Doubly linked list, Circular Linked Lists: operations on it and algorithmic analysis and the complexity analysis.

Trees: Basic Tree Terminologies, Different types of Trees: Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees. M-way Trees, B Trees, B+ Trees: definitions, algorithms and analysis.

Unit 4:

Sorting and Hashing: Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Selection Sort Quick Sort, Merge Sort, Heap Sort; Analysis and Comparison of different sorting algorithms.

Graph: Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis. Minimum Spanning Tree: Kruskal's Algorithm, Prim's Algorithm.

Alternative NPTEL/SWAYAM Course:

SNo	SWAYAM course name	Instructor	Host Institute
1.	Data structures and Algorithms Design	Prof. Nitin Saxena	IIT Kanpur

Suggested books:

1. "Data Structures with C", by Lipschutz Seymour, McGraw Hill Education India.

2. "Fundamentals of Data Structures", Illustrated Edition by Ellis Horowitz, SartajSahni, Computer Science Press.

Suggested reference books:

1. "Data Structures with C", by A.K Sharma, Pearson.

Course code	26LC-ECE-210H				
Category	Program Core Course				
Course title	**Analog circuits Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester-IV**
	0	**0**	**2**	**1**	
Internal Lab	05 Marks				
External lab	20 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

Course Objective

1. **Understand and verify** the practical behavior of analog electronic circuits such as amplifiers, oscillators, and feedback systems.
2. **Analyze**the frequency response, gain, and stability of single-stage and multistage amplifiers through experimental methods.
3. **Design and implement** OP-AMP based circuits including integrator, differentiator, and Schmitt trigger, and verify their characteristics.
4. **Construct and test** oscillator circuits (RC phase shift and Wien Bridge) and study the conditions for sustained oscillations.

Course Outcomes

CO1: Apply theoretical concepts to analyze frequency response of amplifiers using experimental/simulation tools.

CO2: Evaluate the effect of different feedback topologies on amplifier performance parameters.

CO3: Design and verify sinusoidal oscillators (RC and Wien bridge) and analyze their working principles.

CO4: Design and implement OP-AMP based applications such as integrator, differentiator, and Schmitt trigger.

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CO - PO mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3	2	-	-	-	-	-	2	3	2	1
CO2	3	3	2	3	2	1	-	-	-	-	2	3	2	1
CO3	3	3	3	3	2	1	-	-	-	-	2	3	3	1
CO4	3	3	3	3	2	1	-	-	-	-	2	3	3	1
WT. AVG	3	3	2.5	3	2	1					2	3	2.5	1
Overall Mapping of Subject														2.16

List of experiments:

1. To analyze and study frequency response of single and multistage amplifier.
2 To analyze and study different types of feedback topology.

3. To analyze and study RC phase shift oscillator.

4 .To analyze and study wein bridge oscillator.

5. To analyze and study the op-amp as an Integrator.

6. To analyze and study the op-amp as a differentiator.

7. To analyze and study CE amplifier and calculate its gain.

8. To analyze and study 555 timer as a square wave generator.

9. To design Schmitt trigger using Op-amp and verify its operational characteristics

10. To analyze and study working of Push-Pull amplifier.

11. To design and study astablemultivibrator using 555 timer.

12. To design and study monostablemultivibrator using 555 timer.

Reference Books:

1. Millman&Halkias: Integrated Electronics, TMH.

2. Boylestad&Nashelsky: Electronic Devices & Circuit Theory, PHI.

3. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Saunder's College Publishing, Edition IV

Note: Atleast eight (8) experiments from the above list are mandatory to perform for the students

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

ONLINE LINK FOR EXPERIMENT:

1. https://iitb.vlabs.co.in/discipline.html?discipline=Electronics_%26_Communications&utm_source=chatgpt.com
2. https://iitb.vlabs.co.in/

Course code	26LC-ECE-212-H				
Category	Program Core Course				
Course title	**Microprocessor and InterfacingLab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester-IV**
	0	**0**	**2**	**1**	
Internal Lab	05 Marks				
External lab	20 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

Course Objective: Write, debug, and optimize Assembly Language Programs for different applications and demonstrate system interfacing with external devices and peripherals.

CO1: Understand the architecture, instruction set, addressing modes, and programming model of microprocessors/microcontrollers for Assembly Language programming.

CO2: Develop, debug, and optimize Assembly Language Programs to solve a variety of computational and real-time application problems.

CO3: Interface memory, input/output devices, and peripheral modules with microprocessor based systems.

CO4: Design and implement embedded system applications by integrating Assembly Language Programs with hardware interfacing techniques.

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3	2	-	-	-	-	-	2	2	2	
CO2	3	3	2	3	2	1	-	-	-	-	2	3	2	
CO3	3	3	3	3	2	1	-	-	-	-	2	3	3	2
CO4	3	3	3	3	2	1	-	-	-	-	2	3	3	2
WT. AVG	3	3	2.5	3	2	1					2	2.75	2.5	2
Overall Mapping of Subject														2.41

List of Experiments:

Hands-on experiments related to the course contents of Microprocessor and Interfacing Lab

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. N	Experiment Name	Experiment Link(s)
1.	Execute 8085 assembly	https://www.sim8085.com/

	programs directly in browser	
2.	8086 Emulator Online	https://www.jdoodle.com/compile-assembly-x86-online
3.	instruction cycle, memory and processor experiments	https://coa-iitkgp.vlabs.ac.in/exp
4.	Interrupt & Peripheral Interfacing	https://www.vlab.co.in/broad-area-electronics-and-communications

Course code	26LC-PCC-ECE-214H				
Category	Program Core Course				
Course title	**Digital Electronics Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester-IV
	0	**0**	**3**	**1.5**	
Internal Lab	25 Marks				
External lab	25 Marks				
Total	50 Marks				
Duration of Exam	03 Hours				

Course Objective

This Laboratory will help the students to understand and design various logic gates, FF and Counters.

Course Outcomes

CO1	Demonstrate the working of basic TTL gates (AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR) and construct truth tables.	
CO2	Simplify Boolean expressions using Karnaugh Maps (K-Maps) and implement the corresponding logic circuits.	
CO3	Verify the functionality of combinational devices like Multiplexers, Demultiplexers, and 2-bit Comparators.	
CO4	Verify the operation and truth tables of flip-flops: S-R, J-K, T, D.	

CO - PO mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3	2	-	-	-	-	-	2	2	2	
CO2	3	3	2	3	2	1	-	-	-	-	2	3	3	1
CO3	3	3	3	3	2	1	-	-	-	-	2	3	3	2
CO4	3	3	3	3	2	1	-	-	-	-	2	2	2	1

WT. AVG	3	3	2.5	3	2	1					2	2.5	2.5	1.33
Overall Mapping of Subject														2.11

List of experiments:

Perform any 10 Experiments:-

1. Study of TTL gates AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR.
2. Design and realize given function using K-Maps and verify its performance.
3. To verify the operation of Multiplexer and Demultiplexer.
4. To verify the operation of 2bit Comparator using gates.
5. To verify the truth table of S-R,J-K,T, DFlip-flops.
6. To verify the operation of Bi-directional shift register.
7. To design and verify the operation of 3-bit asynchronous counter.
8. To design and verify the operation of 3-bit synchronous counter.
9. To design and verify the operation of asynchronous Up/down counter using J-KFFs.
10. To design and verify the operation of synchronous Up/down counter using J-KFFs.
11. To design and verify the operation of skipping state synchronous counter using JK&T FF
12. To design and verify the operation of 3-bit Ring counter counter.
13. To design and verify the operation of 3-bit Johnson's counter counter
14. Design a state machine of 4 states.
15. To design a sequence detector.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. N	Experiment Name	Experiment Link(s)
1.	On line verify the AND, OR, NOT, NAND, NOR, XOR, MUX, demux, comparators, flip flops, etc., and simulate behavior.	https://academo.org/demos/logic-gate-simulator/?utm_source=chatgpt.com
2.	**verify truth tables of RS, JK, T, and D flip-flops** using logic gate**)**	https://de-iitr.vlabs.ac.in/exp/truth-tables-flip-flops/simulation.html?utm_source=chatgpt.com
3.	Synchronous and asynchronous counter, Ring counter	https://deldsim.com/?utm_source=chatgpt.com
4.	State machine and sequence	https://www.elab.iitb.ac.in

	Detector	

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Course code	26PCC-ECE-216-H				
Category	Program Core Course				
Course title	SPEECH AND AUDIO PROCESSING				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester-IV**
	3	0	0	3	
Classwork	25 Marks				
Examination	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Course Objectives:

The objectives of this course are to:

1. **Understand** the mechanism of human speech production and perception, and the fundamentals of speech signal characteristics.
2. **Explain** different speech coding techniques including waveform, parametric, and hybrid coders.
3. **Apply** signal processing techniques such as pitch estimation, linear prediction, spectral analysis, and quantization for speech signals
4. **Analyze and design** Linear Prediction Coding (LPC) based speech encoder and decoder systems.

COURSE OUTCOMES (CO):

By the end of the Course, Students will be able to:

CO1: Explain speech production mechanism, auditory system, and classification of speech coders.
CO2: Apply signal processing techniques for speech analysis including LPC and pitch estimation.
CO3: Analyze and implement scalar and vector quantization techniques for speech coding.
CO4: Design LPC-based speech encoder and decoder models.

CO - PO mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	2	-	-	-	-	-	-	1	-	1	2	2	1
CO2	3	3	2	2	2	1	-	-	-	-	1	3	3	2
CO3	3	3	2	2	2	-	-	-	-	-	1	3	2	1

CO4	3	3	3	2	2	1	-	1	-	-	1	3	3	2
WT. AVG	3	2.75	2.33	2	2	1		1	1		1	2.75	2.5	1.5
Overall Mapping of Subject														2.25

Unit-I

Introduction- Speech production and modeling - Human Auditory System; General structure of speech coders; Classification of speech coding techniques – parametric, waveform and hybrid ; Requirements of speech codecs –quality, coding delays, robustness.

Unit-II

Speech Signal Processing- Pitch-period estimation, all-pole and all-zero filters, convolution; Power spectral density, periodogram, autoregressive model, autocorrelation estimation. Linear Prediction of Speech- Basic concepts of linear prediction; Linear Prediction Analysis of non-stationary signals –prediction gain, examples; Levinson-Durbin algorithm; Long term and short-term linear prediction models; Moving average prediction. Speech Quantization- Scalar quantization–uniform quantizer, optimum quantizer, logarithmic quantizer, adaptive quantizer, differential quantizers; Vector quantization – distortion measures, codebook design, codebook types.

Unit-III

Scalar Quantization of LPC- Spectral distortion measures, Quantization based on reflection coefficient and log area ratio, bit allocation; Line spectral frequency – LPC to LSF conversions, quantization based on LSF. Linear Prediction Coding- LPC model of speech production; Structures of LPC encoders and decoders; Voicing detection; Limitations of the LPC model.

Unit-IV

Code Excited Linear Prediction-CELP speech production model; Analysis-by-synthesis; Generic CELP encoders and decoders; Excitation codebook search – state-save method, zeroinput zero- state method; CELP based on adaptive codebook, Adaptive Codebook search; Low Delay CELP and algebraic CELP. Speech Coding Standards-An overview of ITU-T G.726, G.728 and G.729standards

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Digital Speech Processing	Prof.Shyamal Kumar Das Mandal	IITKHARAGPUR

Text/ Reference Books

1. “Digital Speech” by A.M.Kondoz, Second Edition (Wiley Students Edition) latest edition
2. “Speech Coding Algorithms: Foundation and Evolution of Standardized Coders”, W.C.Chu, WileyInter science, latest edition

Course code	26LC-ECE-218-H				
Category	Program Core Course				
Course title	**Workshop and PCB Design lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester-IV

	0	**0**	**2**	**1**
Internal Lab	05 Marks			
External lab	20 Marks			
Total	25 Marks			
Duration of Exam	03 Hours			

Course Objective

1. **Provide practical exposure** to electronic measuring instruments such as CRO, DMM, and function generator.
2. **Develop understanding**of active and passive electronic components and their ratings/specifications.
3. **Impart hands-on skills** in transformer winding, soldering techniques, and fabrication of a DC regulated power supply.
4. **Introduce PCB technology**, including identification of PCB types, PCB design software, a Artwork preparation, etching, and drilling processes

Course Outcomes

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

CO1: Identify and operate electronic measuring instruments such as CRO, DMM, and function generator.
CO2: Identify and analyze various active and passive components based on ratings and specifications.

CO3: Perform transformer winding, soldering, and fabrication of DC regulated power supply safely.

CO4: Design and fabricate simple PCB using PCB design software and laboratory techniques..

CO - PO mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	2	3	-	1	1	-	-	1	3	2	1
CO2	3	3	-	2	2	1	1	-	-	-	1	3	2	1
CO3	3	2	3	2	2	1	2	2	-	-	1	3	3	2
CO4	3	2	3	2	3	1	1	2	-	-	1	3	3	2
WT. AVG	3	1.75	3	2	2.5	1	1.25	1.66			1	3	2.5	2
												Overall Mapping of Subject		2.5

List of experiments:

1. Study of CRO, DMM and Function generator.
2. Study of various types of active and passive components based on their ratings.
3. Design a circuit for a fixed power supply
4. Soldering shop: fabrication of dc regulated power supply.
5. Identification of various types of Printed Circuit Boards (PCB) and soldering techniques.
6. Introduction to PCB design software.
7. PCB printing using screen printing or any other technique.
8. PCB Lab:

- Artwork & printing of simple PCB.
- Etching & drilling of PCB.

9. Coating of etched PCB to protect it from oxidation.
10. Fabrication& placing of components as per above power supply circuit.
11. Testing of above circuit.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. N	Experiment Name	Experiment Link(s)
1.	PCB DESIGN	https://fab-coep.vlabs.ac.in/exp/pcb-design-fabrication/