Kavayitri Bahinabai Chaudhari
NORTH MAHARASHTRA UNIVERSITY,
JALGAON (M.S.)

Third Year Bachelor of Engineering

In

Electronics & Telecommunication

(As per NEP 2020 Guidelines)

Faculty of Science and Technology

'A' Grade
NAAC Re-Accredited
(4th Cycle)

SYLLABUS STRUCTURE

For Affiliated Colleges

Semester – V & VI

W.E.F. 2026 – 27

Syllabus Structure for Third Year Engineering (Semester – V, Level – 5.5) (Electronics & Telecommunication) (w. e .f. 2026 – 27)

(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
EC 501	Signals and System	PCC	3			3	40	60			100	3
EC 502	Signals and System Lab	PCC			2	2			25	25 (PR)	50	1
EC 503	Microprocessors & Micro controllers	PCC	3			3	40	60			100	3
EC 504	Microprocessors & Micro controllers Lab	PCC			2	2			25	25 (PR)	50	1
EC 505	Control System Lab	PCC	3		4	7			50	25 (OR)	75	5
EC 506	Program Elective Course – I	PEC	3			3	40	60			100	3
EC 507	Program Elective Course – I Lab	PEC			2	2			25		25	1
EC 508	Internet of Things	MD M	2			2	40	60	25		125	2
OE 509	Open Elective – III	OE	2			2			25		25	2
			16		**10**	**26**	**160**	**240**	**175**	**75**	**650**	**21**

ISE: Internal Sessional Examination ESE: End Semester Examination ICA: Internal Continuous Assessment CA:

College Assessment UA: University Assessment

Program Elective Course – I		
Course Code		**Name of the Subject / Course**
EC 506	A	Analog Integrated Circuits
EC 506	B	Sensors & Automation
EC 506	C	Information Theory & Coding Technique

Syllabus Structure for Third Year Engineering (Semester – VI, Level – 5.5) (Electronics & Telecommunication) (w. e. f. 2026 – 27)

(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
EC 601	Digital Signal Processing	PCC	3			3	40	60			100	3
EC 602	Digital Signal Processing Lab	PCC			2	2			25	25 (PR)	50	1
EC 603	Microwave Theory and Technique	PCC	3			3	40	60			100	3
EC 604	Microwave Theory and Technique Lab	PCC			2	2			25	25 (PR)	50	1
EC 605	Program Elective Course – II Lab	PEC	3		4	7			50	25 (OR)	75	5
EC 606	Program Elective Course – III	PEC	3			3	40	60			100	3
EC 607	Program Elective Course – III Lab	PEC			2	2			25		25	1
EC 608	Digital Image Processing	MD M	2			2	40	60	25		125	2
EC 609	Fault Finding in PCB	VSEC	1		2	3			25		25	2
			15		**12**	**27**	**160**	**240**	**175**	**75**	**650**	**21**

ISE: Internal Sessional Examination ESE: End Semester Examination ICA: Internal Continuous Assessment CA: College Assessment UA: University Assessment

Program Elective Course – II Lab			Program Elective Course – III		
Course Code		Name of the Subject / Course	Course Code		Name of the Subject / Course
EC 605	A	CMOS Design Lab	EC-606	A	Electromagnetic Waves
EC 605	B	Antenna Theory Lab	EC-606	B	Embedded System & RTOS
EC 605	C	Robotics & Automation Lab	EC-606	C	Audio & Speech Processing

EXIT COURSE FOR U.G.B. VOCATIONAL in Electronics & Telecommunication (DURATION 8 WEEKS)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
EC 610	Internship / Apprenticeship	OJT							125			4
EC 611	Mini Project	Project							25			4

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(4th Cycle)

COURSE OUTLINE

For Affiliated Colleges

Semester – V

W.E.F. 2026– 27

SIGNALS AND SYSTEM (PCC)					
COURSE OUTLINE					
Course Title:	**SIGNALS AND SYSTEM**	**Short Title:**	**S&S**	**Course Code:**	**EC-501**

Course description:

This course is designed to lay the foundation for further studies in areas such as communication, signal processing, and control systems etc. This course will explore the basic concepts of signals and systems. Students will understand and learn various types of signals, signal operations and representation of signal and system in time and frequency domain using Fourier and Laplace transform. In this course, more emphasis is given on analysis of continuous time signals and systems.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03

Prerequisite course(s):

Knowledge of basic Electrical and Electronics Engineering and its concept.

Course objectives:

1. To make strong foundation of basics of signals and systems.
2. To understand the representation of signals and systems.
3. To learn different transforms for Digital Signal Processing.
4. To understand the linear time-invariant (LTI) systems and compute its response.
5. To understand the sampling and reconstruction of signal.

Course outcomes:

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

1. Students will describe the mathematical concepts of signal representation and its analysis.
2. Students will analyze the spectral characteristics of signals using different transforms.
3. Students will apply the mathematical concept to describe the linear time variant systems.
4. Students will apply the concept of signal and system for sampling and reconstruction of signal.
5. Students will able to apply the basic knowledge of signal and system in real time applications in day to day life.

SIGNALS AND SYSTEM

COURSE CONTENT

SIGNALS AND SYSTEM		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):UA**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):CA	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction to Signal and System :-Definition of signal, basic operation on signal such as addition, multiplication, time scaling, time shifting, folding and amplitude scaling, continuous time and discrete time signal, various classification of signal such as energy and power, casual and anticasual signal, the discrete time unit impulse and unit step sequence, classification of system as static and dynamic, time invariant and time variant, linear and nonlinear, casual and non-casual, stable and unstable.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Linear shift-invariant (LSI) systems: - Linear shift-invariant (LSI) systems, impulse response and step response, convolution, input output. Behaviour with aperiodic convergent inputs. Characterization of causality and stability of linear shift-invariant systems. System representation through differential equations and difference equations.

Unit–III	No. of Lectures: 09 Hours	Marks:12

Fourier series & Fourier Transform: - Fourier series representation, the Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase Response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem.

Unit–IV:	No. of Lectures: 09 Hours	Marks:12

Laplace Transform & Z –Transform:-The Laplace Transform, notion of Eigen functions of LSI systems, a basis of Eigen functions, region of convergence, poles and zeros of system, Laplace domain analysis, solution to Differential equations and system behaviour. The z-Transform for discrete time signals and systems-Eigen functions, region of convergence, z-domain analysis.

Unit–V:	No. of Lectures: 09 Hours	Marks:12

Sampling &Reconstruction of Signal:-State-space analysis and multi-input, multi-output representation. The state-transition matrix and its properties. The Sampling Theorem and its implications- Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold, and so on. Aliasing and its effects.

Text Books:

1. A.V. Oppenheim, A.S. Willsky and I.T. Young, "Signals and Systems", Prentice Hall, 1983.
2. John G. Proakis, Dimitris G. Manolakis, “Digital Signal Processing Principles, algorithms and applications”, Pearson Prentice Hall, Fourth edition

Reference Books:

1. Papoulis, "Circuits and Systems: A Modern Approach", HRW, 1980.
2. B.P. Lathi, "Signal Processing and Linear Systems", Oxford University Press, 1998.

NPTEL LINK :

1. Signals & System by Prof. K.S. Venktesh, IIT Kanpur, https://media.dev.nptel.ac.in/content/mp4/117/104/117104074/MP4/mod01lec01.mp4
2. Domain & Range by Prof. K.S. Venktesh, IIT Kanpur, https://media.dev.nptel.ac.in/content/mp4/117/104/117104074/MP4/mod01lec02.mp4
3. System Introduction by Prof. K.S. Venktesh, IIT Kanpur, https://media.dev.nptel.ac.in/content/mp4/117/104/117104074/MP4/mod01lec03.mp4
4. Signal Properties by Prof. K.S. Venktesh, IIT Kanpur, https://media.dev.nptel.ac.in/content/mp4/117/104/117104074/MP4/mod01lec04.mp4
5. Frequently used Continuous Signal by Prof. K.S. Venktesh, IIT Kanpur, https://media.dev.nptel.ac.in/content/mp4/117/104/117104074/MP4/mod01lec05.mp4
6. State Space Approach by Prof. A.P. Tiwari, IIT Mandi, https://www.nptelprep.in/courses/108106374/videos?utm_source

SIGNALS AND SYSTEM LAB (PCC)					
LAB COURSE CONTENT					
Course Title:	**SIGNALS AND SYSTEM Lab**	**Short Title:**	**S&SL**	**Course Code:**	**EC-502**

Course description:

In this course, the student will acquire hands-on experience with programming in any open Source like Scilab or Python. Scilab or Python will enable you to study and understand the theory behind signals and systems as well as validate the theory with real-word examples. The labs will cover linear time-invariant systems, Fourier series and Fourier transform, sampling, Digital filters, along with several accompanying digital signal-processing (DSP) applications.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	2	15	30	1

End Semester Exam (ESE) Pattern		**Practical (PR)**	
LAB COURSE CONTENT			
SIGNALS AND SYSTEM LAB		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam (ESE) UA:PR**	**25 marks**
		Internal Continuous Assessment (ICA) :CA	**25 marks**

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. Introduction to Python /Scilab.
2. To create user defined functions for generating sinusoidal signal, delta function, unit step Function and periodic signal.
3. To create user defined functions for signal operation: signal addition, time shifting, time Scaling and time inversion.
4. To compute convolution of two signals and verify its properties.
5. To compute auto-correlation and cross-correlation of two signals and verify its properties.
6. To obtain the response of LTI system defined by linear constant coefficient difference equations.
7. To analyse the periodic signal using Fourier series.
8. To analyse the spectrum of the signal using Fourier transform and verify its properties.

Guidelines for ICA:

Student must submit ICA in the form of journal. Each experiment should be well documented. Faculty in charge will assess the experiment continuously and grade or mark each experiment on completion date declared for each experiment.

Guidelines for ESE:

ESE will be based on the laboratory experiment submitted by the student in the form of journal. Evaluation will be based on the understanding and execution.

MICROPROCESSORS & MICROCONTROLLERS (PCC)					
COURSE OUTLINE					
Course Title:	**Microprocessors & Microcontrollers**	**Short Title:**	**MPMC**	**Course Code:**	**EC-503**

Course description:

This subject covers basic knowledge of microprocessor (8085 & 8086) and microcontroller (8051). Similarly the 8051 microcontroller internal on chip devices, peripheral interfacing and their assembly language programming is covered in this subject. Microcontroller is basic Building block of all domestic, industrial, consumer goods and other high end products. Automation in every field of life is being used and microcontroller is inbuilt element of these Systems and devices.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03

Prerequisite course(s):

Knowledge first year Basic Electronics is required.

Course objectives:

1. To introduce students with the architecture and operation of typical microprocessors and Microcontrollers.
2. To familiarize the students with the programming and interfacing of microcontrollers.
3. Provide background knowledge and core expertise in microcontroller.
4. To understand the importance of different peripheral devices & their interfacing to 8051.
5. Provide strong foundation for designing real world applications using microcontrollers.

Course outcomes:

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

1. Describe architecture of microcomputer, microprocessor and microcontroller.
2. Describe the program for 8051 in assembly language for given problem.
3. Apply basic knowledge to write program for 8051 in timers/ counters, serial / Parallel Communication ports and Interrupt.
4. Apply basic knowledge for interface I/O devices, memory to 8051 microcontroller.
5. Describe the day to day life applications of microcontroller.

MICROPROCESSORS & MICROCONTROLLERS			
COURSE CONTENT			
MICROPROCESSORS & MICROCONTROLLERS		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):UA**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):CA	**40 marks**
Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**	

Microprocessor Fundamental: Introduction to microcomputer, Block Diagram of microcomputer, Elements of Microcomputer: Microprocessor, Memory, and I/O devices. Types of buses: Address bus, Data bus, and Control bus, Introduction to 8085 and 8086 microprocessors. Functional block diagram and pin diagram of 8085 and 8086, 8085 internal architecture: Registers, ALU, and Bus system, Addressing modes of 8085, Instruction format and instruction classification of 8085.

Unit–II:	No. of Lectures: 09 Hours	Marks: 12
Understanding of Microcontroller: Evolution of microcontrollers, Comparison of Microprocessor and Microcontrollersuch as Intel 8051/PIC/At mega 16 & ARM, Definition of Embedded System, Types of architectures: Harvard and Von-Neumann, Selection factors of microcontroller: Architecture type, speed, word size, instruction set, memory, and I/O capability. Block diagram of 8051 microcontroller, Registers in 8051 and Program Status Word (PSW), Register banks of 8051, 8051 pin diagram and function of each pin, Port structure.		
Unit–III	**No. of Lectures: 09 Hours**	**Marks:12**
Microcontroller Programming: 8051 / 89C51 / XX microcontrollers, Study of datasheets and programming using assembly language, Assembler directives: **ORG, DB, EQU, END, CODE, DATA** and and programming tools such as simulator, emulator and debugger, assembler, cross "C" compiler, Editor, assembler, linker, Addressing modes in 8051 and programming using these modes. **MOVC and MOVX instructions**, Arithmetic instructions, Programming associated with these instructions Logic and Compare Instructions - AND, OR, XOR, NOT, Compare, Rotate. Jump instructions: conditional and unconditional, Stack and subroutine instructions.		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks:12**
Intelligent Control System Design Using Timer, Serial Port and Interrupt: Basic registers of timers and structure of TMOD register, Mode 1 timer programming and generation of large delays, Mode 2 timer programming and counter programming. TCON register structure. Serial communication basics, RS 232, 8051 serial port programming, SCON, RI, and TI. Programming for serial data transmission and reception. Doubling the baud rate.8051 interrupts: Interrupt vs. polling, Interrupt service routine and steps in executing an interrupt, Six interrupts in the 8051 and interrupt priority.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks:12**
Industrial Interfacing Need: Switch interfacing, LED interfacing, 7-segment display interfacing, LCD interfacing, ADC interfacing, DAC interfacing, Sensor interfacing, Motor control: Stepper motor and DC motor, Relay interfacing, External peripherals: Programmable Peripheral Interface (8255),Programmable Timers (8254).		
Text Books:		
1. Ramesh Gaonkar "Microprocessor Architecture, Programming, and Applications with the 8085", PENRAM International Publishers. 2. N Senthil Kumar, M Saravanan, S Jeevananthan, and Satish Shah- Microprocessors and Interfacing (Series - Oxford Higher Education).		
Reference Books:		
1. M.A. Mazidi, J.C. Mazidi, R.D. Mc Kinlay, "The 8051 Microcontroller and Embedded Systems using Assembly and C", Second Edition, Pearson Education. 2. Kenneth Ayala, The 8051 Microcontroller, Third Edition, Delmar Learning, a part of Cengage Learning (India Edition)		
NPTEL LINK : 1) Microprocessors & Microcontrollers by Prof. Santanu Chattopadhyay, IITKharagpur https://www.nptelprep.in/courses/108105102/videos 2) Microprocessors & Microcontrollers by Dr.Indranil Sengupta, IIT Kharagpur https://www.youtube.com/watch?v=SUusup7FfJo 3) Microprocessor ALU, Instruction set by Prof. Santanu Chattopadhyay IIT Kharagpur https://www.youtube.com/watch?v=z3QZaKVMp3s&t=29s		

Microprocessors & Microcontrollers LAB (PCC)					
LAB COURSE CONTENT					
Course Title:	**Microprocessors & Microcontrollers Lab**	**Short Title:**	**MPMCL**	**Course Code:**	**EC-504**

Course description:

This course provides the students with comprehensive study of basics of digital electronics, microprocessors and micro controllers. It deals with 8085, 8086, and 8051 ICs and their interfacing.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	2	15	30	1

End Semester Exam (ESE) Pattern		**Practical (PR)**	
LAB COURSE CONTENT			
Microprocessors & Microcontrollers LAB		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam(ESE) UA:PR**	**25 marks**
		Internal Continuous Assessment (ICA) :CA	**25 marks**

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. Write and Execute program for addition, subtraction.
2. Write and Execute program for multiplication and division.
3. Write and Execute program to flash and roll LED's.
4. Write and Execute program to display 0 to 9 continuously on 7- Segment display.
5. Write and Execute program to interface a single switch and LED, 4X4 matrix switch and 7-Segment display.
6. Write and Execute program to demonstrate interfacing of multiplexed 7-Segment display.
7. Write and Execute program to demonstrate interfacing of DAC.
8. Write and Execute program to demonstrate interfacing of ADC.

Guidelines for ICA:

Student must submit ICA in the form of journal. Each experiment should be well documented. Faculty in charge will assess the experiments continuously and grade or mark each experiment on completion date declared for each experiment.

Guidelines for ESE:

ESE will be based on the laboratory experiment submitted by the student in the form of journal. Evaluation will be based on the understanding and execution.

CONTROL SYSTEM LAB (PCC)

LAB COURSE CONTENT

CONTROL SYSTEM LAB	Semester:	V	Course Code:	EC-505

Course description:

This course provides an introduction to feedback control system covering: basic concept of open loop and close loop system, types of control system and their components, modeling of physical system, transfer function methods. Time response of different order system. Stability method and frequency method such as Bode plot, polar plot, Nyquist criterion analysis of state variables

Teaching Scheme:

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	03	15	45	03
Practical	04	15	60	02

Teaching Scheme:		Examination Scheme:	
Theory	**3 hours/week**	**End semester exam (ESE) : UA**	**25 marks**
Practical:	**4 hours/week**	**Internal Continuous Assessment (ICA): CA**	**50 marks**
Semester Credits	**05**		

End Semester Exam (ESE) Pattern:	Oral (OR)

Course objectives:

1. To gain the knowledge of open and closed loop control systems.
2. To introduce the students with the modeling and analysis of feedback control systems. Concept of transfer function and different methods to determine it.
3. To introduce the students with the transient and steady state response of the system.
4. To understand the concept of time domain & frequency domain analysis.
5. To analyze the system using state space approach.

Course outcomes:

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

1. Describe the fundamental concept and principle of feedback control system.
2. Analyze different transfer function methods.
3. Gain knowledge regarding time domain analysis and stability of control system.
4. Create an ability among the students to analyze control system using root locus and frequency domain methods.
5. Develop among students the concept of state space analysis method and different types of controllers.

COURSE CONTENT

Theory	3 hours/week	Examination Scheme	
Practical:	**4 hours/week**	**End semester exam (ESE): UA OR**	**25 marks**
		Internal Continuous Assessment (ICA): CA	**50 marks**
End Semester Exam (ESE) Pattern:	**Oral (OR)**		

Unit–I:	No. of Lectures: 09 Hours	

Introduction to control system:-Types of control system & open loop and closed loop system, Transfer function of Block diagram algebra, Masons gain formula and transfer function of signal flow graph, Conversion of Block diagram algebra to Signal flow graph.

Unit–II:	No. of Lectures: 09 Hours	

Time Response Analysis and Stability:-Steady state error and error constant, Design

specifications of second order system, Transient response & its specifications, The concept of stability & Necessary condition of stability, Hurwitz stability criterion, Routh stability criterion.		
Unit–III:	**No. of Lectures: 09 Hours**	
Root Locus Method:-General rule to draw root locus, Design of root locus, Effect of addition of open loop poles, Effect of addition of open loops zeros.		
Unit–IV:	**No. of Lectures: 09 Hours**	
Frequency Response Analysis and Stability:- Basics of Magnitude and phase plot, Construction of Bode plot, Polar plot, Nyquist plot, Nyquist stability criterion**.**		
Unit–V:	**No. of Lectures: 09 Hours**	
State Variable Analysis and Controllers:-Concept of state (State variable and state model) State model of linear system, Solution of state equation, Controllability and observability. Stepper motor, Servo motor and synchronous motor.		
Concerned faculty member should suitably frame SIX practical's / assignments from the following list 1. Study the synchros to observe angular displacement. 2. Study of flow control using PID controller using MATLAB. 3. To determine transient response of RLC network using MATLAB. 4. Study of Stepper motor Using MATLAB. 5. Find ξ, Wn &Mp of the response to unit step i/p for given system using MATLAB. 6. Obtain the unit step response of second order system using MATLAB. 7. Sketch the Bode plot for the given transfer function (Unity f/b/ system) using MATLAB. 8. Sketch the Nyquist plot for the given system using MATLAB.		
Text Books:		
1. Gopal. M & I.J.Nagrath "Control Systems: Principles and Design", 4th edition Tata McGraw-Hill, 1997. 2. Kuo, B.C, "Automatic Control System", Prentice Hall, 6th edition, 1993. 3. Ogata, Katsuhiko, "Modern Control Engineering", Prentice Hall, second edition, 1991.		
Reference Books:		
1. I.J. Nagrath & Gopal, "Modern Control Engineering", New Age International, New age 5th edition. 2. Ashok kumar –"Control system" –Tata McGraw Hill Publishing Company. 3. R. Amanda and P. Ramesh Babu- "Control system Engineering"- SciTech Publications. 4. Smarajit Ghosh – "Control systems" 2nd edition – PEARSON publishers.		
NPTEL Link:- 1. Introduction of control system by Prof. M.Gopal http://www.digimat.in/nptel/courses/video/108102043/L03.html 2. Introduction to Bode plot & polar plot by Prof. S .D Agashe. https://kongu.digimat.in/nptel/courses/video/108101037/L41.html		
Guide lines for ICA:		
Students must submit ICA in the form of journal. Each assignment should be well documented. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.		
Guidelines for ESE:		
ESE will be based on drawing/assignment submitted by the student in the form of journal. Evaluation will be based on oral, paper work and performance in the ESE.		

ANALOG INTEGRATED CIRCUITS (PEC– I)					
COURSE OUTLINE					
Course Title:	**Analog Integrated Circuits**	**Short Title:**	**AIC**	**Course Code:**	**EC 506 A**

Course description: This course gives the detailed knowledge of linear integrated circuit especially operational amplifier. The basic operations like inversion, addition, subtraction as well as amplification is analysed in this course. Also, in this course the various applications using op-amp, active filters design, Timer, phase lock loop is mentioned.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03

Prerequisite course(s): Analog Electronics and Control system concepts

Course objectives:

1. To study the concepts of op-amp configurations and their frequency response.
2. To understand fundamental principles of operational amplifier and its parameters.
3. To realize importance of op-amp in the various applications.
4. To analyse different types of Active filters.
5. To study different monolithic IC applications.

Course outcomes:

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

1. Explain basic concept of operational amplifier in open and closed loop mode.
2. Apply configuration of op-amp for various application.
3. Identify and describe different applications of op-amp.
4. Design and implement different active filters.
5. Understand various monolithic IC applications.

COURSE CONTENT

ANALOG INTEGRATED CIRCUITS		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE) : UA**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):CA	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction to Operational amplifier :-Block diagram of Op-amp, Op-amp as an ideal voltage amplifier, Ideal characteristics of Op-amp, IC 741 Op-amp IC, Virtual ground concept, Open loop configuration, closed loop configuration, unity gain amplifier, frequency response of both configurations

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Op-amp parameters and Applications:-DC parameters, AC Parameters, inverting amplifier, non-inverting amplifier, Summing Amplifier, Differential amplifier (substractor), Integrator, differentiator. (Numerical on inverting amplifier, non-inverting amplifier, Summing amplifier)

Unit–III:	**No. of Lectures: 09 Hours**	**Marks:12**

Linear Op-amp Applications:-Precision Rectifier, Log Amplifier, Anti-log Amplifier, inverting comparator, Non-inverting Comparator, Schmitt trigger (Regenerative Comparator), Square wave generator (A stable multivibrator using Op-Amp), Triangular and Saw tooth wave generator.

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks:12**

Active Filters:-Introduction to active filters, analysis & design of Butterworth filters: Low Pass

filter &High Pass filter (First order only), Band Pass filter. Band reject filter. (Numerical on First order filter design)

Unit–V:	**No. of Lectures: 09 Hours**	**Marks:12**

Introduction of IC 555 (timer IC):- Pin diagram, Features, Block diagram, Astable multi-vibrators. Monostable Multivibrator.

Phase Locked Loop (PLL) – Introduction, Lock-in Range, Capture Range, Block diagram, Phase Locked Loop IC NE/SE 565

Text Books:

1. Ramakant A. Gaikwad, “Op Amps and Linear Integrated Circuits” Pearson Education
2. D. Roy Choudary, Shailendra Jain, “Linear Integrated Circuits”, New Age International Pvt. Ltd.

Reference Books:

1. S. Salivahanan, V.S. Kanchana Bhaaskaran, “Linear integrated circuits”, 3rd Edition, McGraw-Hill.
2. William D.Stanely, “Operational Amplifiers with Linear Integrated Circuits”, 4th Edition, Pearson Education.
3. B. Somanathan Nair, “Linear Integrated Circuits- Analysis, Design & Application” Wiley India.
4. Michael Jacob, "Applications and Design with Analog Integrated Circuits, 2nd Edition, Prentice Hall of India

NPTEL LINK :

1. Integrated Circuits and Applications by Prof. Shaikh Rafi Ahamed, IIT Guwahati. https://onlinecourses.nptel.ac.in/noc24_ee73/preview
2. Linear Integrated Circuits, by Dr. Yedukondala Rao Veeranki, NIT Puducherry. https://onlinecourses.swayam2.ac.in/ntr25_ed139/preview

ANALOG INTEGRATED CIRCUITS LAB (PEC-I)					
LAB COURSE CONTENT					
Course Title:	**ANALOG INTEGRATED CIRCUITS LAB**	**Short Title:**	**AICL**	**Course Code:**	**EC-507 A**

Course description:

This course gives the practical knowledge of linear integrated circuit especially operational amplifier. The basic operations like inversion, addition, subtraction as well as amplification are implemented using IC 741. Also, in this course the various applications using op-amp IC 741, active filters design are mentioned.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	2	15	30	1

LAB COURSE CONTENT			
ANALOG INTEGRATED CIRCUITS LAB		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**Internal Continuous Assessment (ICA) :CA**	**25 marks**

Concerned faculty member should suitably frame SIX laboratory experiments from the following list.

1. Study of pin details, specifications, applications and features of IC741 (Op-Amp) and IC 555 (Timer).
2. Study of Operational Amplifier as a Unity gain amplifier.
3. Study of Operational Amplifier as an Adder
4. Study of Operational Amplifier as an Integrator.
5. Study of Operational Amplifier as a Differentiator,
6. Study of Operational Amplifier as a Comparator.
7. Study of Operational Amplifier as Schmitt Trigger
8. Study of Operational Amplifier as first order low pass filter

Guidelines for ICA:

Student must submit ICA in the form of journal. Each experiment should be well documented. Faculty in charge will assess the experiment continuously and grade or mark each experiment on completion date declared for each experiment.

SENSORS & AUTOMATION (PEC-I)					
COURSE OUTLINE					
Course Title:	**SENSORS & AUTOMATION**	**Short Title:**	**SAA**	**Course Code:**	**EC-506B**

Course description: This course introduces the fundamentals of sensors and transducers, including their classification, selection, and applications in measuring physical parameters like displacement, force, pressure, and temperature. It covers various sensing technologies such as thermistors, thermocouples, RTDs, proximity sensors, and flow/level sensors used in industrial and modern systems.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03

Prerequisite course(s):

Basics of different types of sensors and Transducers

Course objectives:

1. To provide the basic understanding of measurement and instrumentation systems and the insight of the sensors.
2. To introduce the concept of the reactive, inductive and capacitive sensors and self-generating sensors.
3. To introduce the concept of Data Acquisition and Types of ADC.
4. To familiarize the characteristics, working principle and application of special purpose transducer
5. To familiarize the concept of signal conditioning.

Course outcomes:

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

1. Gain the basic idea of measurements, characteristics and the errors associated with sensors and Transducer.
2. Demonstrate the concept of resistive, inductive and capacitive sensors that can employed for real life applications.
3. Realize the concept of Data Acquisition and Types of ADC.
4. Understand the working principle of special purpose sensors and the need for developing smart sensors.
5. Understand the working principle of Signal Conditioning.

COURSE CONTENT

		Semester:	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE) : UA**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):CA	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Sensors & Transducer: Definition, Classification & selection of sensors, Measurement of displacement using Potentiometer, LVDT & Optical Encoder, Measurement of force using strain gauge, and Measurement of pressure using LVDT based diaphragm & piezoelectric sensor.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Measurement of temperature:-Using Thermistor, Thermocouple & RTD, Concept of thermal imaging, Measurement of position using Hall effect sensors, Proximity sensors: Inductive &

Capacitive, Use of proximity sensor as accelerometer and vibration sensor, Flow Sensors, Ultrasonic & Laser, Level Sensors: Ultrasonic & Capacitive.

Unit–III:	**No. of Lectures: 09 Hours**	**Marks:12**

Data Acquisition Methods: Basic block diagram, Analog and Digital IO, Counters, Timers, Types of ADC: successive approximation and sigma-delta, Types of DAC: Weighted Resistor and R-2R Ladder type, Use of Data Sockets for Networked Communication.

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks:12**

Intelligent Sensors: General Structure of smart sensors & its components, Characteristic of smart sensors: Self calibration, Self-testing & self-communicating, Application of smart sensors: Automatic robot control & automobile engine control.

Unit–V:	**No. of Lectures: 09 Hours**	**Marks:12**

Signal Conditioning: Introduction, Functions of signal conditioning equipment, need for amplification of signals, Types of amplifiers. Data Acquisition Systems and Conversion: Introduction, Objectives & configuration of data acquisition system, Analog & Digital IO, Counters, Timers, need of data conversion.

Text Books:

1. D. V. S. Murthy, Transducers and Instrumentation, PHI 2nd Edition 2013.
2. D. Patranabis, Sensors and Transducers, PHI 2" Edition 2013.

Reference Book

1. Arun K. Ghosh, "Introduction to measurements and Instrumentation", PHI, 4th Edition 2012.
2. A.D. Helfrick and W.D. cooper, "Modern Electronic Instrumentation & Measurement Techniques", PHI – 2001

NPTEL LINK :

1. Sensors and Actuators by Prof. Hardik Jeetendra Pandya , IISc Bangalore https://nptel.ac.in/courses/108108147
2. Sensor Technologies: Physics, Fabrication, and Circuits by Prof. Mitradip Bhattacharjee, IISER Bhopal https://onlinecourses.nptel.ac.in/noc23_ee95/preview

SENSORS & AUTOMATION LAB (PEC-I)					
LAB COURSE CONTENT					
Course Title:	**SENSORS & AUTOMATION LAB**	**Short Title:**	**SAL**	**Course Code:**	**EC-507 B**

Course description:

These practical's introduces the working principle and construction of the various sensors and its applications. Understand the working principle of special purpose sensors and the need for developing Smart sensors. Students will understand the working principle of Signal Conditioning and automation.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	2	15	30	1

LAB COURSE CONTENT			
SENSORS & AUTOMATION LAB		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**		
		Internal Continuous Assessment (ICA) :CA	**25 marks**

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. Study of LVDT.
2. Measurement of Temperature by using Thermistor.
3. Study of Ultrasonic Sensors.
4. Study of Smart Sensors
5. Study of ADC
6. Study of Proximity Sensor.
7. Study of Strain Gauge.
8. Study of Vibration Sensors.

Guidelines for ICA:

Student must submit ICA in the form of journal. Each experiment should be well documented. Faculty in charge will assess the experiment continuously and grade or mark each experiment on completion date declared for each experiment.

INFORMATION THEORY & CODING TECHNIQUE (PEC–I)					
COURSE OUTLINE					
Course Title:	**Information Theory & Coding Technique**	**Short Title:**	**ITCT**	**Course Code:**	**EC– 506 C**

Course description:

Information is the source of a communication system, whether it is analog or digital. This subject provides data encoding techniques for transmission of signal as well as decoding at receiver. Information theory is a mathematical approach to study the coding of information along with the quantification, storage and communication of information.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03

Prerequisite course(s):

Basic knowledge of Analog and Digital communication

Course objectives:

1. To understand information theory, concept of entropy and source coding.
2. To analyse communication channels, their capacities.
3. To develop and construct Linear Block Codes for data on imperfect communication channels.
4. To develop and construct Convolutional Code for data on imperfect communication channels.
5. To learn Communication Link with noise free environment.

Course outcomes:

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

1. Gain the knowledge of information theory, entropy and source coding.
2. Design and implement communication channels, their capacities.
3. Apply the concepts of Linear Block Codes for data on imperfect communication channels design.
4. Apply the concepts of Convolutional Code data on imperfect communication channels design.
5. Understand Communication Link with noise free environment.

COURSE CONTENT

Information Theory & Coding Technique		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE) : UA**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):CA	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Information Theory:- Introduction, Concept of information, Information and Entropy Information rate, Numerical on Entropy, Source coding, code word, Fix length code word, Average code word length, code efficiency Huffman coding, Numerical on Huffman coding. Source coding theorem.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Channel Capacity And Coding:-Channel, Discrete memory less channels,Joint Probability Joint Entropy, Conditional entropy, Relation between Joint & Conditional Entropy, Mutual Information: Average Mutual Information, Properties of Mutual information.(No Numerical). Channel Capacity, Shannon theorem, Shannon capacity theorem or Hartley theorem for Gaussian noise. Numerical on channel capacity.

Unit–III:	**No. of Lectures: 09 Hours**	**Marks:12**

Linear Block Codes:-Introduction, Linear block code structure, Matrix Description of Linear Block Code, Generator and Parity Check Matrices, Numerical on Linear block code.
Hamming code, code word, code rate code efficiency, hamming distance and hamming weight, minimum distance, Error detection and correction by parity check matrix. Numericals on Hamming code.

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks:12**

Convolutional Code:-Introduction, Tree code, Convolution code, state table, state diagram, Trellis Diagram Analytical representation of convolution encoder, Numerical on convolution encoder, Decoding of convolution code, Sequential Decoding Viterbi Decoding (Algorithm), Numerical on Convolution code Decoder.

Unit–V:	**No. of Lectures: 09 Hours**	**Marks:12**

Communication Link Design:-Multiple Access Technique, Time division multiple access (TDMA), Frequency division multiple access (FDMA), Code division multiple access (CDMA), Comparison between TDMA, FDMA and CDMA. Signal to Noise ratio (SNR) ,Noise figure, Numerical on Signal to Noise ratio (SNR) ,Noise figure.

Text Books:

1. Ranjan Bose, “Information Theory Coding & Cryptography”, Tata McGraw-Hill Publishing Company Ltd Second Edition.
2. John G. Proakis & Masoud Salehi “Digital Communications*”* McGraw-Hill Education, 5th Edition

Reference Books:

1. S.Haykin, “Digital Communications”, Wiley Student Edition,ISBN9971-51-205-X.
2. Arijit Saha, Surajit Mandal, “Information Theory, Coding & Cryptography”, Pearson Education, Ist Edition, 2013.
3. Theodore S. Rappaport, “Wireless Communications: Principles and Practice” Prentice Hall PTR, 2nd Edition.
4. Salvatore Gravano, “Introduction to Error Control Codes”, Oxford University Press, Ist Edition.

NPTEL LINK :

1. Information Theory, Coding and Cryptography, by Prof. Ranjan Bose IIT Delhi https://nptel.ac.in/courses/108102117
2. Information Theory and Coding, by Prof. S.N. Merchant IIT Bombay. https://nptel.ac.in/courses/117101053

INFORMATION THEORY & CODING TECHNIQUE LAB (PEC-I)					
LAB COURSE CONTENT					
Course Title:	**INFORMATION THEORY & CODING TECHNIQUE LAB**	**Short Title:**	**ITCTL**	**Course Code:**	**EC-507 C**

Course description:

This course gives the practical knowledge of data encoding techniques for transmission of signal as well as decoding at receiver.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	2	15	30	1

LAB COURSE CONTENT

INFORMATION THEORY & CODING TECHNIQUE LAB		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**Internal Continuous Assessment (ICA) :CA**	**25 marks**

Concerned faculty member should suitably frame SIX laboratory experiments from the following list.

1. Study of entropy, source coding for a given source.
2. Compute average code word length, efficiency, and redundancy using Huffman code.
3. Design and Performance Analysis of Linear Block Codes.
4. Construct generator and parity check matrices for given block code.
5. Implementation of Hamming Code for Error Detection and Correction.
6. Study of TDMA.
7. Study of FDMA
8. Study of CDMA.

Guidelines for ICA:

Students must submit ICA in the form of Journal. Each experiment should be well documented. Faculty in charge will assess the experiment continuously and grade or mark each experiment on completion date declared for each experiment.

INTERNET OF THINGS (MD M)					
COURSE OUTLINE					
Course Title:	**Internet of Things**	**Short Title:**	**IoT**	**Course Code:**	**EC-508**
Course description: The course familiarizes students with basic terminologies of internet of things and the essential knowledge to get started in the field of IoT.					

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	02	15	30	02

Prerequisite course(s):

Fundamentals of Computer network, Internet Protocols, Sensor networks.

Course objectives:

1. To study the fundamental concepts of Architecture and physical design of IoT.
2. To understand the machine to machine interface in IoT.
3. To study and interfacing of various sensors in IoT.
4. To learn various communication protocols.
5. To study and understand IoT platforms like arduino, Raspberry Pi.

Course outcomes:

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

1. Understand fundamental concept as well as architecture of Internet of Things.
2. Apply the knowledge of wireless sensors network for machine to machine interface.
3. Implement various sensors interface with IoT.
4. Apply various communication protocols with IoT applications.
5. Design and implement various IoT applications with IoT platforms.

COURSE CONTENT

Internet of Things		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**2 hours/week**	**End semester exam (ESE) : UA**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):CA	**40 marks**
		Internal Continuous Assessment (ICA) : CA	**25 marks**

Unit–I:	**No. of Lectures: 06 Hours**	**Marks: 12**

Introduction To IOT:-Definition & Characteristics of IoT –IoT Framework and Architecture, Physical design of IoT, IoT Protocols, IoT communication Models, IoT levels & Templates, IoT Enabled technologies.

Unit–II:	**No. of Lectures: 06 Hours**	**Marks: 12**

Supporting platform of IoT:-Wireless sensor network, Cloud Computing, Embedded Systems, Big Data Analysis, UAV, Web Services, IoT& M2M-Machine to Machine, Difference between IoT & M2M.

Unit–III:	**No. of Lectures: 06 Hours**	**Marks:12**

Things In IoT:-Wireless sensor, level sensors, Embedded Sensors, Actuators –connecting LED, Buzzer, Controlling-AC power devices, Protocols: I2C, SPI, UART, and USART, CAN.

Unit–IV:	**No. of Lectures: 06 Hours**	**Marks:12**

Communication Protocols & IoTchallenges:-Introduction to Non-IP based protocol IEEE,802.11,IEEE 802.15Blue tooth, Zegbee, IP Based Protocol (IPV4,IPV6,6LoWPAN), Application layer protocol (MQTT,AMQP).

Unit–V:	**No. of Lectures: 06 Hours**	**Marks:12**

IOT platform & its Programming:-Introduction to Arduino & Raspberry Pi installation, Interfaces (Serial, Spi, I2C), Introduction to Python program with Raspberry Pi.

Text Books:

1. Shriram K Vasudevan, Abhishek S. Nagarajan , " Internet of Things", RMD Sundaram, John Wiley.
2. Internet of Things: "An Easy Hands-on Approach", Tech Sar Pvt. Ltd. publication.

Reference Books:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things" CISCO Press, 2017.
2. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill
3. Sudip Mishra, Anandarup Mukherjee, Arijit Roy: "Introduction to IOT", Cambridge University.

NPTEL LINK :

1. Introduction to Internet of Things by Prof. Sudip Misra, IIT Kharagpur
   https://online courses.nptel.ac.in/noc22_cs53/preview
2. Introduction To Industry 4.0 & Industrial Internet of Things by Prof. Sudip Misra, IIT Kharagpur
   https://onlinecourses.nptel.ac.in/no c22_cs52/preview

Concerned faculty member should suitably frame SIX assignments from the following list.

1. IoT frame work and Architecture, IoT Protocols.
2. IoT Enabled technologies.
3. Wireless sensor network, Cloud computing and big data analysis.
4. Machine to Machine interface.
5. Wireless sensors, USB sensors, embedded sensors.
6. To interface the LED with Arduino.
7. To interface buzzer with Arduino.
8. To interface LCD with Arduino.

Guidelines for ICA:

Students must submit ICA in the form of journal. Each assignment should be well documented. Faculty in Charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.

Open Elective – III

A Student can opt for any one subject out of available institute wide subjects defined in the following list as Open Elective provided, he/she has not taken that particular subject in his/her Programme core, Programme elective, Multidisciplinary Minor, other Open elective and Vocational and Skill Enhancement courses etc. throughout his / her four years of UG Engineering Programme. The student must opt a subject that is compulsorily from faculty other than that of the Major discipline.

Course Code	Name of the Subject / Course	Faculty Offered by	Department Offered by
Open Elective - III (w.e.f. 2026 - 27 at Semester - V, Third Year Engineering)			
OE – 509 A	Legal Aspects of Business	Comm. & Mgmt.	Management
OE – 509 B	Modern Office Management	Comm. & Mgmt.	Commerce
OE – 509 C	Food Adulteration and Safety	Sci. & Tech.	Environment
OE – 509 D	Insurance Management	Comm. & Mgmt.	Commerce
OE – 509 E	Indian Social Problems	Humanities	Sociology
OE – 509 F	Disaster Management	Sci. & Tech.	Environment
OE – 509 G	Pharma Marketing Management	Sci. & Tech.	Pharmacy
OE – 509 H	Circular Economy	Humanities	Economics

LEGAL ASPECTS OF BUSINESS (Open Elective – III)					
COURSE OUTLINE					
Course Title:	**LEGAL ASPECTS OF BUSINESS**	**Short Title:**	LAB	**Course Code:**	OE – 509 A

Course description:

This course provides a concise overview of the legal framework governing business in India, covering contracts, sale of goods, negotiable instruments, intellectual property rights, company law, and cyber law. It equips students with basic legal knowledge and practical understanding required for lawful, ethical, and effective business decision-making in a digital environment.

Lecture	Hours/week	No. of weeks	Total hours	Semester credits
	02	15	30	02

Prerequisite course(s):

Basics of Law, Legal Environment of Business, Mercantile Law

Course objectives:

The objective of this course is to impart knowledge so that the student will:

1. To understand the basic concepts and rules of contracts as per the Indian Contract Act.
2. To learn the legal provisions related to sale of goods and negotiable instruments.
3. To know the importance and protection of intellectual property rights with reference to the Patents Act, Copyright Act, and Trade Marks Act.
4. To understand the basic structure and working of companies according to the Companies Act.
5. To understand digital laws, cybercrimes, and data protection as guided by the Information Technology Act.

Course outcomes:

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

1. Understand the basic principles and essentials of contracts under the Indian Contract Act.
2. Apply provisions of Sale of Goods and Negotiable Instruments laws in business transactions.
3. Explain the importance and protection of Intellectual Property Rights in business.
4. Understand the formation and legal framework of companies under company law.
5. Identify cyber laws, digital transactions, and data protection under the Information Technology Act.

COURSE CONTENT

LEGAL ASPECTS OF BUSINESS		Semester:	V
Teaching Scheme:		**Examination scheme**	
Lectures:	**2 hours/week**	**Internal Continuous Assessment (ICA) :CA**	**25 marks**

Unit–I:	No. of Lectures: 06 Hours	

INDIAN CONTRACT ACT, 1872

Contract: Definition and meaning-Essentials of contract
Classification of Contracts, Offer and Acceptance
Consideration: Definition, Essentials of a Valid Consideration –Capacity to contract
Free Consent: Coercion, Undue influence, Fraud, Misrepresentation and Mistake

Unit–II:	No. of Lectures: 06 Hours	

SALES OF GOODS ACT, 1930 & Negotiable Instruments Act 1881

Sale of Goods Act 1930: Sale and agreement to sell, Conditions and warranties, Transfer of ownership, rights of unpaid seller.
Negotiable Instruments Act 1881: Meaning, type of negotiable instruments; promissory note, bill of exchange, cheque. Endorsement and negotiation, Dishonor and legal remedies

Unit–III:	**No. of Lectures: 06 Hours**	
INTELLECTUAL PROPERTY RIGHTS		
Intellectual Property Rights-Meaning, Need and Importance of Intellectual Property Patents Act, 1970 (2002): Definition, Objectives, Nature, and Types of Patents, Transfer of Patent Rights, Rights of Patentee. Copyright Act, 1957-Concept, Objectives, Nature, Criteria for protection, Ownership, Duration, and Copy Right in Computer Programs. Trademark Act 1999 (Amendment Act 2010)- Concept, Registration, rights of registered proprietor, infringement and defenses.		
Unit–IV:	**No. of Lectures: 06 Hours**	
COMPANIES ACT, 1956 (Amended 2013)		
Meaning, Definition and characteristics and kinds of company. Memorandum of Association - Meaning, Purpose, Contents Doctrine of Ultra-Vires Articles of Association - Meaning Purpose, Content. Alternation, Constructive Notice		
Unit–V:	**No. of Lectures: 06 Hours**	
The Information Technology Act, 2000 (Amended 2008)		
Introduction, Digital Signatures and Electronic records, Electronic governance Cyber-crimes: hacking, phishing, identity theft, cyber fraud and remedies Data protection, privacy and digital compliance Important Provision of Information Technology Act 2000		
Text Books:		
1. Legal Aspects of Business (8th ed.). McGraw Hill Education. - Akhileshwar Pathak		
Reference Books:		
1. Legal Aspects of Business – David Albuquerque 2. Business Law – N.D.Kapoor 3. Mercantile Law – M. C. Kuchhal and Vivek Kuchhal		
NPTEL Links: • https://nptel.ac.in/courses/129106006 • https://onlinecourses.swayam2.ac.in/e-learning/preview/cec21_mg02 • https://onlinecourses.nptel.ac.in/noc26_mg30/preview		
Guidelines for ICA:		
Students must submit ICA in the form of journal. Concerned faculty member should suitably frame **FIVE** assignments based on the above syllabus. Faculty in charge will assess the assignments continuously, and grade or mark each assignment on completion date declared for each assignment.		

MODERN OFFICE MANAGEMENT (Open Elective – III)					
COURSE OUTLINE					
Course Title:	**MODERN OFFICE MANAGEMENT**	**Short Title:**	MOM	**Course Code:**	OE – 509 B

Course description:

This course introduces the concepts and practices of modern office management in a technology-driven environment. It covers office structure, layout, communication, documentation, and record management, along with digital office tools and automation. The course also focuses on office personnel management, professional behaviour, productivity skills, and emerging trends preparing students to manage contemporary offices effectively.

Lecture	Hours/week	No. of weeks	Total hours	Semester credits
	02	15	30	02

Prerequisite course(s):

Fundamentals of Office Administration, Business Communication, Office Administration and Secretarial Practice

Course objectives:

The objective of this course is to impart knowledge so that the student will:

1. To understand basics of modern office management and emerging office trends.
2. To learn office layout, systems, and workplace environment management.
3. To develop skills in office communication, documentation, and services.
4. To understand records management, meetings, and office automation.
5. To build competencies in personnel management and productivity skills.

Course outcomes:

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

1. Explain concepts and modern trends of office management.
2. Apply office layout, systems, and environmental principles.
3. Demonstrate office communication, documentation, and services.
4. Analyze records management, meetings, and office automation.
5. Evaluate personnel management, productivity, and emerging trends.

COURSE CONTENT

MODERN OFFICE MANAGEMENT		Semester:	V
Teaching Scheme:		**Examination scheme**	
Lectures:	**2 hours/week**	**Internal Continuous Assessment (ICA) :CA**	**25 marks**

Unit–I:	No. of Lectures: 06 Hours	

Introduction to Modern Office Management

Modern Office: Meaning, Definition, Characteristics, Functions and Past–Present–Future

Office Management: Meaning, Elements and Office as Service & Information Centre

Office Organisation: Office Manager- Functions, Duties, Responsibilities

Modern Trends in Office: Paperless Office and Virtual Office

Unit–II:	No. of Lectures: 06 Hours	

Office Layout and Environment

Office Systems: Objectives, Flow of Work, Planning and Scheduling
Office Layout: Meaning, Objectives, Principles, Types
Office Infrastructure & Facilities Management
Office Environment: Meaning, Factors & Importance Office Safety & Remedies

Unit–III:	No. of Lectures: 06 Hours	

Office Communication, Forms and Services

Office Communication: Internal & External Communication, Digital Communication
Business Documentation: Report Writing, Documentation and Office Correspondence
Office Forms: Types, Control, Stationery- Standardisation and Issues
Mail & Communication Services: Courier, Speed Post, Fax and E-mail Services

Unit–IV:	**No. of Lectures: 6 Hours**	
Office Record Management		
Records Management: Meaning, Objectives and Organisation of Record Department Office Meetings - Meaning, Definition, Purpose, Types of meeting Filing & Retrieval Systems: Physical and Electronic Records, Retention and Disposal Digital Office & Automation: E-Office, Office Software Tools and Automation Systems		
Unit–V:	**No. of Lectures: 06 Hours**	
Office Personnel Management and Emerging Trends		
Office Personnel Management: Types, Qualities, Recruitment, and Training Professional Behaviour: Ethics, Discipline, Leadership and Team Coordination Productivity Skills: Time Management and Stress Management Emerging Trends in Office: Remote Work and Green Office Practices		
Text Books:		
• Office Management & Control – G.R.Terry		
Reference Books:		
1. Office Organization and Management – S. P. Arora, Vikas Publishing House Pvt. Ltd., New Delhi. 2. Office Organisation & Management – R.K. Chopada & Ankita Chopada, Himalaya Publishing House, Mumbai. 3. Office Management – I. M. Sahai, Kitab Mahal, Allahabad. 4. Office Management – P. K. Ghosh, Sultan Chand & Sons, New Delhi.		
NPTEL Links: • https://onlinecourses.swayam2.ac.in/e-learning/preview/nou23_mg05 • https://onlinecourses.swayam2.ac.in/e-learning/preview/cec21_mg24 • https://onlinecourses.swayam2.ac.in/e-learning/preview/imb24_mg54		
Guidelines for ICA:		
Students must submit ICA in the form of journal. Concerned faculty member should suitably frame **FIVE** assignments based on the above syllabus. Faculty in charge will assess the assignments continuously, and grade or mark each assignment on completion date declared for each assignment.		

FOOD ADULTERATION AND SAFETY (Open Elective – III)					
COURSE OUTLINE					
Course Title:	**FOOD ADULTERATION AND SAFETY**	**Short Title:**	FAS	**Course Code:**	**OE – 509 C**

Course description:
This course is designed to impart basic knowledge on identifying major types of food adulterants and contamination, food safety hazards using engineering and microbiological principles, Interpret food laws and regulatory standards relevant to engineering practice.
Also, to emphasize the roles of students in basic food safety management frameworks.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	02	15	30	02

Prerequisite course(s):

Course objectives:

The objective of this course is to:

1. To introduce the principles of food safety, food adulteration, and regulatory standards.
2. To explain types, sources, and detection of food adulterants using scientific and engineering approaches.
3. To familiarize students with national and international food safety regulations including FSSAI, Codex, ISO and HACCP.
4. To develop understanding of food contaminants, toxicants, and risk assessment methodologies.
5. To apply quality assurance and analytical techniques relevant to food safety monitoring.

Course outcomes:

Upon successful completion of this course the student will be able to:

1. Explain concepts of food safety, hazards, and adulteration mechanisms.
2. Identify and classify food adulterants and contaminants in different food matrices.
3. Apply analytical and instrumental techniques for detection of adulterants.
4. Interpret regulatory frameworks and food safety management systems.
5. Analyze risk assessment models and quality control measures in food systems.

COURSE CONTENT

FOOD ADULTERATION AND SAFETY		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**2 hours/week**	**Internal Continuous Assessment (ICA) :CA**	**25 marks**

Unit–I:	**No. of Lectures: 06 Hours**

Fundamentals of Food Safety and Adulteration

- Concept and importance of food safety
- Definitions: Food safety, food quality, food security
- Types of food hazards: Biological, Chemical, Physical
- Concept of food adulteration
- Intentional and incidental adulteration
- Food contamination vs adulteration
- Food safety challenges in developing countries
- Overview of global food safety issues
- Role of regulatory bodies
- Food standards and their significance

Unit–II:	**No. of Lectures: 06 Hours**

Food Adulterants and Contaminants

- Common food adulterants in cereals, pulses, milk, fats & oils, spices

- Chemical contaminants: Pesticide residues, heavy metals, industrial chemicals
- Natural toxins: Mycotoxins, plant toxins, marine toxins
- Veterinary drug residues
- Food additives and misuse
- Packaging contaminants
- Emerging contaminants
- Health effects of adulterants
- Case studies of major food adulteration incidents.

Unit–III:	**No. of Lectures: 06 Hours**	

Detection and Analytical Techniques

- Sampling methods and protocols
- Classical methods of detection
- Chromatographic techniques (HPLC, GC)
- Analytical Methods (UV-Vis, IR, NMR, Mass Spectrometry)
- Biosensors in food safety
- Molecular methods (PCR-based detection)
- Rapid detection kits
- Validation of analytical methods

Unit–IV:	**No. of Lectures: 06 Hours**	

Food Safety Regulations and Standards

- Codex Alimentarius Commission
- WTO agreements (SPS & TBT)
- Food Safety and Standards Act (India)
- FSSAI regulations
- ISO 22000 and Food Safety Management Systems
- HACCP principles and implementation
- Good Manufacturing Practices (GMP)
- Good Hygienic Practices (GHP)
- Risk analysis framework
- Traceability and recall systems.

Unit–V:	**No. of Lectures: 06 Hours**	

Risk Assessment and Quality Assurance

- Risk assessment framework
- Hazard identification
- Exposure assessment
- Dose-response assessment
- Risk characterization
- Quality control tools
- Statistical quality control in food industry
- Validation and verification
- Food safety auditing
- Emerging technologies in food safety monitoring.

Text Books:

1. Food Safety and Standards, K. Ramawat & J. Kumar, CRC Press / Springer
2. Food Safety & Quality Assurance: Principles and Practices, Sunetra Roday, Wiley
3. Food Safety and Standards in India, B. Srilakshmi, New Age International

Reference Books:

1. Food Analysis, S. Suzanne Nielsen, Springer
2. Principles of Food Toxicology, D. R. Heldman & D. B. Lund (Ed.), Springer / CRC Press

NPTEL Links:

- **Food Safety and Quality Management**
  https://nptel.ac.in/courses/126105011
- **Food Packaging Technology**
  https://nptel.ac.in/courses/126105010
- **Food Chemistry and Technology**
  https://nptel.ac.in/courses/126105013
- **Food Processing and Preservation**
  https://nptel.ac.in/courses/126105012

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INSURANCE MANAGEMENT (Open Elective – III)					
COURSE OUTLINE					
Course Title:	**INSURANCE MANAGEMENT**	**Short Title:**	IM	**Course Code:**	**OE – 509 D**

Course description:
This course provides a fundamental understanding of insurance concepts, principles, and practices. It covers life and general insurance products, legal and regulatory frameworks, underwriting and claims management, and the role of insurance in economic development. The course equips students with essential knowledge of insurance operations and industry practices, preparing them for opportunities in the insurance and financial services sector.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	02	15	30	02

Prerequisite course(s):
Basic knowledge of Commerce / Economics
Fundamental understanding of Financial Systems and Banking

Course objectives:
The objective of this course is:
1. To introduce students to the basic concepts, principles, and functions of insurance.
2. To provide knowledge of life and general insurance products and their features.
3. To familiarize students with the legal and regulatory framework of insurance in India.
4. To understand the role of insurance in economic development and financial stability.
5. To develop understanding of insurance operations including underwriting and claims management.

Course outcomes:
After successful completion of this course the student will be able to:
1. Explain the fundamental principles and functions of insurance.
2. Differentiate various life and general insurance products.
3. Describe the legal and regulatory framework governing insurance in India.
4. Analyze the contribution of insurance to economic development.
5. Understand underwriting, claims settlement, and operational practices in insurance companies.

COURSE CONTENT

INSURANCE MANAGEMENT		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**2 hours/week**	**Internal Continuous Assessment (ICA) :CA**	**25 marks**

Unit–I:	**No. of Lectures: 06 Hours**	

Fundamentals of Insurance
Meaning and definition of insurance Nature, scope and functions of insurance
Evolution and importance of insurance
Principles of insurance – Utmost Good Faith, Insurable Interest, Indemnity, Subrogation, Contribution, Proximate Cause
Types of insurance

Unit–II:	**No. of Lectures: 06 Hours**	

Life and General Insurance Products
Life Insurance – Term, Whole Life, Endowment, Annuities & Pension Plans
Basic concept of premium and mortality table
General Insurance – Fire, Marine, Motor and Health Insurance
Crop, Rural and Group Insurance
Maturity and Death Claims

Unit–III:	**No. of Lectures: 06 Hours**	

Legal and Regulatory Framework of Insurance
LIC Act, 1956
General Insurance Act, 1972

IRDA Act, 1999 and Functions of IRDA
Actuaries Act, 2006
Regulatory and ethical practices in insurance

Unit–IV:	**No. of Lectures: 06 Hours**	

Insurance and Economic Development

Role of insurance in economic development
Growth of life and general insurance in India
Liberalization of insurance sector and its impact
Issues, challenges and future potential of insurance industry

Unit–V:	**No. of Lectures: 06 Hours**	

Insurance Operations and Governance

Underwriting – Meaning and principles (Life & General Insurance)
Claims Management – Life and General Insurance
Insurance agents – Licensing, functions and code of conduct
Consumer protection and grievance redressal mechanism

Text Books:

1. **Fundamentals of Insurance** – Dr. P.K. Gupta, Himalaya Publishing House

Reference Books:

1. Insurance: Principles And Practice – M.N. Mishra & S B Mishra, S Chand Publishing
2. Principles of Insurance Management – Neelam C Gulati, Excel Books
3. **Principles and Practice of Insurance by P. Periasamy** A.K. Basu, Himalaya Publishing House

ONLINE COURSES SWAYAM Links:

https://onlinecourses.swayam2.ac.in/e-learning/preview/cec20_mg24

Guidelines for ICA:

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INDIAN SOCIAL PROBLEMS (Open Elective – III)					
COURSE OUTLINE					
Course Title:	**INDIAN SOCIAL PROBLEMS**	**Short Title:**	ISP	**Course Code:**	**OE-509 E**

Course description:
This course introduces students to the sociological understanding of major social problems in India. The course includes the concept, characteristics, and approaches to the study of social problems and proceeds to examine key issues such as poverty, unemployment, population growth, and urbanization. It further explores violence against women, child labour, crime, and corruption as structural challenges affecting Indian society.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	02	15	30	02

Prerequisite course(s):

Course objectives:
The objective of this course is:
1. Understand the concept and approaches to social problems in the Indian context.
2. Analyze fundamental economic and demographic social issues in India.
3. Examine population growth and urbanization and their effects on society.
4. Understand gender and child-related social problems with sociological insight.
5. Identify and evaluate crime and corruption as structural social problems.

Course outcomes:
After successful completion of this course the student will be able to:
1. Explain the sociological concept and approaches to social problems.
2. Discuss poverty and unemployment with causes and consequences.
3. Analyze the issues of population growth and urbanization in India.
4. Describe violence against women and child labour with social impacts.
5. Explain crime and corruption as social problems and suggest measures.

COURSE CONTENT

INDIAN SOCIAL PROBLEMS		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**2 hours/week**	**Internal Continuous Assessment (ICA) :CA**	**25 marks**

Unit–I:	**No. of Lectures: 06 Hours**	

Social Problems: Meaning, Characteristics of Social Problems, Types of Social Problems, Approaches to the Study of Social Problems: Social Pathology Approach, Social Disorganization Approach, Value-Conflict Approach, Deviance Approach, Methods of Studying Social Problems

Unit–II:	**No. of Lectures: 06 Hours**	

Poverty: Meaning & Types, Causes of Poverty, Consequences of Poverty, Measures for Eradication
Unemployment: Meaning & Types, Causes, Consequences, Measures to Reduce Unemployment

Unit–III:	**No. of Lectures: 06 Hours**	

Population Growth: Growth of Population in India, Causes & Consequences, Population Control Measures
Urbanization: Meaning of Urbanization, Causes of Urbanization, Problems of Urbanization, Remedies for Urban Problems

Unit–IV:	**No. of Lectures: 06 Hours**	

Violence Against Women: Meaning & Forms, Causes & Consequences, Measures to Control
Child Labour & Child Abuse: Meaning & Causes, Problems of Child Labour & Abuse, Measures to Eliminate

Unit–V:	**No. of Lectures: 06 Hours**	

Crime and Criminals: Meaning of Crime, Types of Crime, Causes, Prevention & Control
Corruption: Meaning of Corruption, Causes & Consequences, Measures to Control Corruption

Text Books:

1. Ahuja, Ram. *Social Problems in India*. 4th ed., Rawat Publications, 2021.

Reference Books:

1. G. R. Madan – Indian Social Problems, Allied Publishers
2. C. N. Shankar Rao – Sociology of Indian Society, S. Chand Publications
3. Vidya Bhushan & D. R. Sachdeva – Introduction to Sociology, Kitab Mahal Publications
4. M. N. Srinivas – Social Change in Modern India, Orient Longman / Oxford University Press
5. R. Desai – Rural Sociology in India, Bombay Popular Prakashan

NPTEL Links:

1. https://onlinecourses.swayam2.ac.in/cec25_hs92/preview
2. https://onlinecourses.nptel.ac.in/noc24_hs140/preview

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DISASTER MANAGEMENT (Open Elective-III)					
COURSE OUTLINE					
Course Title:	**DISASTER MANAGEMENT**	**Short Title:**	**DM**	**Course Code:**	**OE – 509 F**

Course description:
The course aims to develop an understanding of disaster management concepts, disaster risk reduction, preparedness, response, and recovery, with emphasis on managing natural and man-made disasters effectively.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	**02**	**15**	**30**	02

Prerequisite course(s):

Course objectives:

The objective of this course is to:

1. Understand fundamental concepts of disasters, hazard, vulnerability, risk and their engineering relevance.
2. Identify and classify natural and anthropogenic disasters and their underlying causes.
3. Explain disaster management principles, phases of disaster cycle and mitigation strategies.
4. Describe institutional frameworks, stakeholders, tools, and technologies used in Disaster Management in India and globally.
5. Apply learned skills to analyze disaster case studies, ethical issues and engineering interventions for disaster risk reduction.

Course outcomes:

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

1. Define and explain key disaster concepts, types and impacts.
2. Distinguish between natural and man-made disasters and summaries control measures.
3. Illustrate stages of disaster management cycle and preparedness planning.
4. Evaluate roles of different stakeholders and tools in managing disaster events.
5. Analyze disaster case studies and articulate ethical, legal and policy issues.

COURSE CONTENT

DISASTER MANAGEMENT		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**2 hours/week**	**Internal Continuous Assessment (ICA) :CA**	**25 Marks**

Unit–I:	**No. of Lectures: 06**	

Introduction & Disasters Fundamentals

Overview of Disaster Management: Definitions: Disaster, Hazard, Risk, Vulnerability, Capacity, Historical perspective & impacts (environment, society, economy)
Understanding Disasters: Nature, causes & classification of disasters, Concept of exposure, resilience, capacity

Unit–II:	**No. of Lectures:06**	

Natural & Anthropogenic Disasters

Natural Disasters: Earthquakes, Tsunami, Volcanoes, Cyclones, Floods, Droughts, Landslides, Extreme weather events and climate change impacts.
Anthropogenic (Man-made) Disasters: Industrial accidents, fires, pollution events,

Transportation failures, structural failures.

Unit–III:	No. of Lectures: 06	

Pandemics, Environmental Disasters & Management Principles

Pandemics and Environmental Disasters: COVID-19 case insights and environmental disaster context.
Objectives & Principles of Disaster Management: Prevention, preparedness, mitigation, response and recovery concepts.
Disaster Management Cycle: Phases, actions and key engineering considerations

Unit–IV:	No. of Lectures: 06 Hours	

Stakeholders & Institutional Framework

Stakeholders in Disaster Management: Government agencies, NGOs, community groups, Technological tools (Early Warning Systems, GIS, Remote Sensing).
International Cooperation & Organizational Structures: UN agencies, regional alliances and global frameworks
Disaster Management in India: Institutional framework, NDMA, policy & legal context.

Unit–V:	No. of Lectures: 06 Hours	

Ethical Issues & Case Studies

Ethical Issues in Disaster Management: Resource allocation, social equity and engineering ethics
Case Studies: Natural and man-made disaster case analyses, Lessons learnt, best practices.

Text Books:

1. R. Subramanian, Disaster Management, Vikas Publishing House.
2. S.C.Sharma, Disaster Management Khanna Publishing House, New Delhi.
3. G. K. Ghosh, Disaster Management, APH Publishing Corporation, New Delhi

Reference Books:

1. A.K. Singh, Disaster Management in India, New Royal Book Company, Lucknow
2. Anu Kapur Vulnerable India: A Geographical Study of Disasters, Sage Publications, New Delhi
3. Tushar Bhattacharya, Disaster Science and Management, McGraw-Hill Education (India)
4. Jagbir Singh (Ed.), Disaster Management: Future Challenges and Opportunities, Disaster, I.K. International Publishing House

Online Courses:

NIDM E-Learning Courses (National Institute of Disaster Management)
https://elearning.nidm.gov.in/local/home/index.php
SWAYAM & NPTEL MOOCs
https://archive.nptel.ac.in/courses/105/104/105104183/
iGOT Karmayogi (For Govt. Officials)
https://igotkarmayogi.gov.in/#/

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PHARMA MARKETING MANAGEMENT (Open Elective – III)					
COURSE OUTLINE					
Course Title:	**PHARMA MARKETING MANAGEMENT**	**Short Title:**	PMM	**Course Code:**	OE – 509 G

Pharmaceutical Marketing Management focuses on the planning, implementation, and control of marketing strategies specific to the pharmaceutical industry, where ethical considerations, regulatory compliance, and patient safety play a critical role. It involves understanding healthcare markets, consumer and physician behavior, product life-cycle management, pricing strategies, distribution channels, and promotional activities such as medical detailing, digital marketing, and relationship management with healthcare professionals. The discipline integrates market research, brand management, and strategic decision-making to ensure effective product positioning while complying with national and international regulations. In an increasingly competitive and technology-driven environment, pharmaceutical marketing management emphasizes value-based marketing, patient-centric approaches, and sustainable growth.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	02	15	30	02

Course objectives:

The objective of this course is to:

1. To study the scope of marketing.
2. To study the quantitative and qualitative aspects of pharmaceutical market.
3. To study the products decision in product life cycle, product portfolios, packaging and labelling decisions.
4. To study the promotion of products.
5. To study marketing channels and management of logistics.

Course outcomes:

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

1. Understand and explain core marketing concepts and their application in the pharmaceutical industry.
2. Understand quantitative and qualitative aspects of pharmaceutical market.
3. Understand the product cycle, product portfolios.
4. Assess promotional tools including personal selling, advertising, digital marketing, and ethical promotion practices.
5. Understand the marketing channels and management of logistics.

COURSE CONTENT

PHARMA MARKETING MANAGEMENT		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**2 hours/week**	**Internal Continuous Assessment (ICA): CA**	**25 marks**

Unit–I:	**No. of Lectures: 6 Hours**	

Marketing:

Definition, general concepts and scope of marketing; Distinction between marketing & selling; Marketing environment; Industry and competitive analysis; Analyzing consumer buying behavior; industrial buying behavior.

Pharmaceutical Market:

Quantitative and qualitative aspects; size and composition of the market; demographic descriptions and socio-psychological characteristics of the consumer; market segmentation & targeting. Consumer profile; Motivation and prescribing habits of the physician; patients' choice of physician and retail pharmacist. Analyzing the Market; Role of market research.

Unit–II:	**No. of Lectures: 6 Hours**	

Product Decision:

Classification, product line and product mix decisions, product life cycle, product portfolio

analysis; product positioning; New product decisions; Product branding, packaging and labeling decisions, Product management in pharmaceutical industry.

Unit–III:	No. of Lectures: 6 Hours	

Promotion:

Methods, determinants of promotional mix, promotional budget; An overview of personal selling, advertising, direct mail, journals, sampling, retailing, medical exhibition, public relations, online promotional techniques for OTC Products.

Unit–IV:	No. of Lectures: 6 Hours	

Pharmaceutical Marketing Channels

Designing channel, channel members, selecting the appropriate channel, conflict in channels, physical distribution management: Strategic importance, tasks in physical distribution management.

Management of Logistics:

Supply Chain, Cold Chain, Applications of IT & management information systems for efficient marketing, controlling expiry and returned goods.

Unit–V:	No. of Lectures: 6 Hours	

Pricing:

Meaning, importance, objectives, determinants of price; pricing methods and strategies, issues in price management in pharmaceutical industry. An overview of DPCO (Drug Price Control Order) and NPPA (National Pharmaceutical Pricing Authority).

Emerging concepts in marketing:

Vertical & Horizontal Marketing; Rural Marketing; Consumerism; Industrial Marketing; Global Marketing.

AI in Pharma Marketing:

Introduction to AI in Pharma Marketing: Role of AI in modern pharmaceutical marketing, Benefits, limitations, and future scope of AI in pharma, AI-driven market research and forecasting

Text Books:

1. Arun Kumar and N Menakshi: Marketing Management, Vikas Publishing, India.
2. Ramaswamy, U.S & Nanakamari, S: Marketing Management: Global Perspective, Indian Context, Macmilan India, New Delhi.

Reference Books:

1. Philip Kotler and Kevin Lane Keller: Marketing Management, Prentice Hall of India New Delhi

NPTEL Links:

1. https://youtu.be/iOZxUvq1JNE
2. https://nptel.ac.in/courses/110104068

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CIRCULAR ECONOMY (Open Elective – III)					
COURSE OUTLINE					
Course Title:	**CIRCULAR ECONOMY**	**Short Title:**	**CE**	**Course Code:**	**OE-509 H**

Course description:
This course introduces the concept of Circular Economy, its principles, and its relevance in sustainable development. Students will learn about linear economy limitations, circular economy frameworks, business models, and its implementation in India.

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	02	15	30	02

Prerequisite course(s):
Basic understanding of **Linear Economy and environmental sustainability concepts**.

Course objectives:
The objective of this course is:
1. To understand the basics of Circular Economy and its significance.
2. To familiarize students with circular economy frameworks, business models, and case studies.
3. To compare linear and circular economies, and understand traditional circular practices.
4. To understand the prospect of circular economy in India.
5. To analyze the role of government and benefits of circular economy.

Course outcomes:
After successful completion of this course the student will be able to:
1. Describe the principles and benefits of Circular Economy.
2. Apply circular economy frameworks and business models.
3. Compare and contrast linear and circular economies.
4. Identify opportunities for circular economy in India.
5. Understand the role of government and benefits of circular economy for various stakeholders.

COURSE CONTENT

CIRCULAR ECONOMY		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**2 hours/week**	**Internal Continuous Assessment (ICA) :CA**	**25 marks**

Unit–I:	**No. of Lectures: 06 Hours**	

Linear Economy and Circular Economy Basics

Linear Economy - Our Crumbling Planet: Law of Obsolescence, Disadvantages of Linear Economy,

Circular Economy: Think Ahead - Our Last Chance:- Elements of a Circular Economy, Why do we need to switch to a circular economy?

Unit–II:	**No. of Lectures: 06 Hours**	

Circular Economy Frameworks and Business Models

Fundamental Characteristics of Circular Economy - A Resource Multiplier: Innovation, Collaboration, Value optimization, Design out Waste, Renewable Energy, Closed and tighter loops, Business Models in a Circular Economy- Circular supply chain, Product as a service, Collaborations and sharing, Recovery and recycling, Product life extension, McKinsey Center for Business and Environment - the ReSOLVE framework

Unit–III:	**No. of Lectures: 06 Hours**	

Linear Vs. Circular Economy and Traditional Practices

Linear Vs Circular Economy: Differential that whither the Planet and Us? - Material value preservation, Eco-effectiveness from eco-efficiency, Shift from Raw material to residual flows, Linear VS Circular economy, SWOT analysis of Circular Economy,

Circular Economy - Old wine in new bottle: - Yoga – a circular alternate to gyms, Ayurveda – An old circular alternate to modern medicine, Earthen Pots – An old circular practice, Sun Drying – A circular alternate to laundry dryers		
Unit–IV:	**No. of Lectures: 06 Hours**	
Circular Economy in India		
India and Circularity - Showcasing Sustainable Future - Circularity in India, Prospect of Circular Economy in India, Role of Indian businesses, Invest in circular economy opportunities		
Unit–V:	**No. of Lectures: 06 Hours**	
Circular Economy Implementation and Benefits		
Role of Government -Set direction and show commitment, Enabling regulatory frameworks, Platforms for multi-stakeholder collaboration, Support circular models through public procurement and infrastructure Benefits of Circular Economy for India- Benefits for businesses and the Economy, Benefits for the environment, Benefits for citizens		
Text Books:		
Reference Books: Circular Economy: (Re)Emerging Movement by Shalini Goyal Bhalla		
NPTEL Links: SWAYAM https://onlinecourses.swayam2.ac.in/e-learning/preview/aic21_ge19		
Guidelines for ICA:		
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Kavayitri Bahinabai Chaudhari

NORTH MAHARASHTRA UNIVERSITY,

JALGAON (M.S.)

Third Year Bachelor of Engineering

In

Electronics & Telecommunication

(As per NEP 2020 Guidelines)
Faculty of Science and Technology

'A' Grade
NAAC Re-Accredited
(4th Cycle)

COURSE OUTLINE

For Affiliated Colleges

Semester – VI

W.E.F. 2026– 27

DIGITAL SIGNAL PROCESSING (PCC)					
COURSE OUTLINE					
Course Title:	**DIGITAL SIGNAL PROCESSING**	**Short Title:**	**DSP**	**Course Code:**	**EC-601**

Course description: Digital Signal Processing (DSP) is concerned with the representation, transformation and manipulation of signals on a computer. After half a century advances, DSP has become an important field, and has penetrated a wide range of application systems, such as consumer electronics, digital communications, medical imaging, and power applications. With the dramatic increase of the processing capability of signal processing, it is the expectation that the importance and role of DSP is to accelerate and expand.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03

Prerequisite course(s):

Knowledge of Mathematics, control system, Signal and System

Course objectives:

The objective of this course is
1. To introduce finding DFT, IDFT and FFT of discrete signal.
2. To design IIR filter form analog filters.
3. To study techniques for converting IIR filters to FIR filters.
4. To understand the finite word length effect in digital filters and multirate systems.
5. To study DSP processors and their applications.

Course outcomes:

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

1. Understand the findings of the DFT, IDFT, and FFT of discrete signals.
2. Understand the concept of analog filters and the design of IIR digital filters.
3. Understand the need and design of FIR digital filters.
4. Analyze finite word length effects on signals.
5. Understand multirate signal processing.

COURSE CONTENT

		Semester:	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):UA**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):CA	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Discrete Fourier Transform & Fast Fourier Transform—DSP Preliminaries: - Definition and properties of DFT and IDFT. Circular convolution of sequences using DFT (Max. N = 8). Twiddle factor. Fast Fourier Transforms (FFT): Radic-2 decimation-in-time and decimation-in-frequency FFT algorithms, inverse FFT, and an introduction to composite FFT.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

IIR Digital Filters: - Design of IIR filters from analog filters using the impulse invariance method and the bilinear transformation method. IIR filter realization using direct form, cascade form, parallel form, & transposed form. Butterworth, Chebyshev, and Elliptic approximations.

Unit–III:	**No. of Lectures: 09 Hours**	**Marks:12**

FIR Digital Filters:-Minimum phase, maximum phase, and mixed phase filters. Design of FIR filters using window techniques (Rectangular, Hamming, and Hanning). Design of FIR filters using the frequency sampling technique, and FIR filter realization using direct form, cascade form, and linear phase form.		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks:12**
Finite Word Length effects in Digital Filters: - Quantization, truncation, and rounding. Effects due to truncation and rounding. Input quantization error, product quantization error, and coefficient quantization error. Zero-input limit cycle oscillations and overflow limit cycle oscillations. Finite word length effects in FIR digital filters.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks:12**
Multirate DSP: - Introduction to up sampler, down sampler, and two-channel filter banks. Applications of multirate signal processing in communication, music processing, image processing, and radar signal processing.		
Text Books:		
1. S. Salivahanan, "Digital Signal Processing", McGraw Hill Education; 3rd edition, 2017. 2. P. Ramesh Babu,"Digital Signal Processing",Sci -Tech Publications (India) Pvt.,6th edition, 2014. 3.Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital Signal Processing", A Practical Approach by, Pearson Education 4. Tarun Kumar Rawat, Digital Signal Processing", Oxford University Press, 2015.		
2. **Reference Books:**		
1. Proakis J.,Manolakis D., "Digital Signal Processing",4th Edition, Pearson Education. 2. Sanjit K. Mitra, "Digital Signal Processing–A Computer Based Approach"–4th Edition , McGraw Hill Education (India) Private Limited. 3. Oppenheim A. Schafer R. ,Buck J.," Discrete Time Signal Processing",2nd Edition, Pearson Education.		
NPTEL Link:		
1. Digital Signal Processing, IIT Madras by Prof. C. S. Ramalingam https://nptel.ac.in/courses/108106151 2. Digital Signal Processing, IIT Delhi by Prof. S.C. Dutta Roy Digital Signal Processing, IIT Delhi. https://nptel.ac.in/courses/117102060		

DIGITAL SIGNAL PROCESSING LAB (PCC)					
LAB COURSE OUTLINE					
Course Title:	**DIGITAL SIGNAL PROCESSING LAB**	**Short Title:**	**DSPL**	**Course Code:**	**EC-602**

Course description:

Digital Signal Processing Lab objectives is practical implementation of the convolution, Correlation, DFT, IDFT, Block convolution, Signal smoothing, filtering of long duration signals, And Spectral analysis of signals.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	2	**15**	**30**	**1**

End Semester Exam (ESE) Pattern	**Practical (PR)**

LAB COURSE CONTENT

Digital Signal Processing Lab		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme:**	
Practical:	**2hours/week**	**End Semester Exam(ESE):(PR)**	**25marks**
		Internal Continuous Assessment (ICA):CA	**25marks**

Concerned faculty member should suitably frame SIX experiments from the following list.

1. To find DFT/IDFT of given DFT signal.
2. Implementation of FFT of given sequence.
3. Determination of Power Spectrum of a given signal.
4. Implementation of LP and HP FIR filter for a given sequence.
5. Implementation of LP and HP IIR filter for a given sequence.
6. Implementation of Decimation Process.
7. Implementation of Interpolation Process.
8. Implementation of I/D sampling rate converters.

Guidelines for ICA:

Students must submit ICA in the form of journal. Each experiment should be well documented. Faculty in charge will assess the experiments continuously and grade or mark each experiment on completion date declared for each experiments.

Guidelines for ESE:

ESE will be based on the Laboratory experiments submitted by the students in the form of journal. In the ESE (PR), the students may be asked to perform the practical experiments with minor modification.

MICROWAVE THEORY AND TECHNIQUE (PCC)					
COURSE OUTLINE					
Course Title:	**MICROWAVE THEORY AND TECHNIQUE**	**Short Title:**	**MTT**	**Course Code:**	**EC-603**

Course description:

This course is designed to lay the foundation of microwave theory. The various modes of Propagations through wave guides are included. Students will become familiar with the usage of active and passive components of microwave systems. Measurements of various parameters of microwave systems and Modern trends of microwave engineering.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03

Prerequisite course(s):

Electromagnetic theory, Wave propagation, Antennas and Semiconductor physics.

Course objectives:

1. To study the basics concept of various mode of propagation in waveguide.
2. To understand the fundamentals of microwave passive components.
3. To familiarize the concept of microwave active devices.
4. Provide strong foundation for understanding of microwave measurement and microwave antenna.
5. To learn the modern trends in Microwave Engineering.

Course outcomes:

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

1. Describe the basic concepts and applications of microwave systems.
2. Analyse, test and use various passive microwave components for different applications.
3. Describe the concept of microwave active tubes.
4. Apply the concept for measurement of various parameters of microwave system.
5. To describe the modern trends in Microwave Engineering.

COURSE CONTENT

Microwave Theory and Technique		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):UA**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):CA	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction to Microwaves:-History of Microwaves, Microwave Frequency bands; General Application of Microwave, Advantages-Rectangular, Circular, & Disadvantages. Types of waveguide, Mathematical Model of Microwave Transmission-Concept of Mode, Features of TEM, TE and TM Modes, Mathematical derivation of TEM Mode, TM Mode, TE Mode, Cut off frequency ,Phase velocity, Group Velocity ,Guide wavelength, wave Impedance for rectangular waveguide.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Passive Microwave Devices:- Microwave passive components: E Plane Tee, H- Plane Tee Magic Tee, Directional Coupler, Analysis with S Matrix ,Attenuator, Frequency meter, Ferrite Devices-Isolator, circulator, Microwave filters, Matched Terminations, waveguide Bends, Twist.

Unit–III	No. of Lectures: 09 Hours	Marks:12
Active Microwave Devices: - Microwave tubes: Klystron, TWT, Backward Wave Oscillator, and Magnetron. Gunn Diodes, Tunnel diode, PIN diodes, Varactor diodes, IMPATT and TRAPATT diodes, Parametric Amplifiers.		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks:12**
Microwave Measurements: - Frequency-Electronics Method, Mechanical Method, Power, VSWR, attenuation, Impedance measurement. **Microwave Antennas:** Fundamental parameters of antennas**,** Horn antenna, and Parabolic reflector with all types of feeding methods, slotted antenna, and Lens antenna.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks:12**
Modern Trends in Microwaves Engineering:-Effect of Microwaves on human body, Medical and Civil applications of microwaves, Electromagnetic interference / Electromagnetic Compatibility (EMI / EMC), Monolithic Microwave IC fabrication, RF MEMS for microwave components. **Microwave Systems-**Wireless Communications system, Radar Systems, Radiometer Systems.		
Text Books:		
1. Samuel Liao, "Microwave Devices and Circuits", Pearson Education, 3/e. 2. Annapurna Das, Sisir Das, "Microwave Engineering", TMH, 3/e		
Reference Books:		
1. Robert E Collin, "Foundations for Microwave Engineering", Wiley India, 2/e. 2. Sisodia, Gupta, "Microwaves: Introduction to Circuits, Devices and Antenna", New Age, 1/e. 3. Manojit Mitra, "Microwave Engineering", Dhanpat Rai, 3/e.		
NPTEL LINK : 1. Design Principles of Microwave Antennas by Amitabha Bhattacharya, Analysis and IIT Kharagpur https://youtu.be/h51mFbIgZRI?si=vIJWH9WRH3POyrZs 2. Microwave Theory and Techniques by Prof. Girish Kumar, IIT Bombay https://onlinecourses.nptel.ac.in/noc20_ee63/preview?utm_source		

MICROWAVE THEORY AND TECHNIQUE LAB (PCC)					
LAB COURSE CONTENT					
Course Title:	**MICROWAVE THEORY AND TECHNIQUE LAB**	**Short Title:**	**MTTL**	**Course Code:**	**EC-604**

Course description:

This course is designed to provide hands-on experimental exposure to microwave engineering concepts essential for understanding high-frequency communication systems. The course introduces students to microwave frequency bands, waveguide structures, and propagation mechanisms, enabling them to analyze electromagnetic wave behavior in rectangular and circular waveguides. Experiments focus on the measurement of key waveguide parameters such as cutoff frequency, phase and group velocity, guide wavelength, and wave impedance for various modes of propagation (TE, TM, and TEM).

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	2	15	30	1

End Semester Exam(ESE) Pattern	**Pattern Practical (PR)**

LAB COURSE CONTENT			
MICROWAVE THEORY AND TECHNIQUE LAB		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam(ESE) UA:PR**	**25 marks**
		Internal Continuous Assessment (ICA) :CA	**25 marks**

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. Plot and study V-I Characteristics of GUNN Diode
2. Plot and study Reflex Klystron Characteristics.
3. Measurement of Attenuation (Fixed and Variable).
4. Measurement of isolation and coupling factor of magic tee.
5. Measurement of coupling factor and directivity of Directional coupler.
6. Measurement of insertion loss and isolation of circulator and isolator.
7. Measurement of VSWR (using Vmax / Vmin method).
8. Measurement of polar pattern and the gain of waveguide horn antenna.

Guidelines for ICA:

Students must submit ICA in the form of a journal. Each experiment should be well documented. The faculty in charge will assess the experiments continuously and grade or mark each experiment on the completion date declared for each experiment.

Guidelines for ESE:

ESE will be based on the laboratory experiments submitted by the students in the form of a journal. Evaluation will be based on understanding and execution.

CMOS DESIGN LAB (PEC-II)				
LAB COURSE CONTENT				
CMOS DESIGN LAB	**Semester:**	**VI**	**Course Code:**	**EC- 605A**

Course description: - The scope of the course covers both digital and analog design based standard or custom cells development. Layout fundamentals, both digital & analog analysis (passive components, variations, mismatches etc.)

Prerequisite course(s):

1. Basic Electronics
2. Semiconductor Devices
3. Introduction to Analog Electronics
4. Introduction to Digital Electronics

Teaching Scheme:

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03
Practical	04	15	60	02

Course objectives:

1. To understand different CMOS logic families and their circuit layout.
2. To understand various VLSI design methodologies.
3. To learn how to model, analyze digital integrated circuits.
4. To learn how to simulate digital integrated circuits.
5. To design digital integrated circuits.

Course outcomes:

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

1. Describe the CMOS Logic families & their circuit layout.
2. Describe various VLSI design methodologies.
3. Analyze the analog & digital CMOS circuits for specified applications.
4. Simulate digital integrated circuits.
5. Acquire knowledge to Design of Data Processing Elements using VHDL

COURSE CONTENT

Theory	**3 hours/week**	**Examination Scheme**	
Practical:	**4 hours/week**	**End semester exam (ESE): UA OR**	**25 marks**
		Internal Continuous Assessment (ICA): CA	**50 marks**
End Semester Exam (ESE) Pattern:	**Oral (OR)**		

Unit–I:	**No. of Lectures: 09 Hours**	

Introduction to CMOS Technology:-MOS Transistors, MOS Transistors Switches. CMOS Logic: The Inverter, Combinational Logic, The NAND Gate, NOR Gate, Compound Gates, Multiplexers, Memory-Latches and Registers.

Unit–II:	**No. of Lectures: 09 Hours**	

CMOS Processing Technology:-Silicon Semiconductor Technology: An overview: Wafer Processing, Oxidation, Epitaxy, Deposition, Ion-Implantation, and Diffusion. The silicon Gate Process. Basic CMOS Technology: A basic n-well CMOS Process, The p-well process, Twin – Tub Process, Circuit Elements: Resistors, Capacitors.

Unit–III:	**No. of Lectures: 09 Hours**	

Combinational Circuit Design:-Comparison of Circuit families: Static CMOS, Rationed Circuits, and Cascode Voltage Switch Logic. Dynamic Circuits and Dual- Rail Domino Multiple Output Domino Logic, BiCMOS Circuits: BiCMOS NAND Gate.

Unit–IV:	**No. of Lectures: 09 Hours**	

Sequential Circuit Design: - Sequencing Static Circuits. Design of latches and flip flops, Conventional CMOS Latches, Pulsed Latches. Conventional CMOS Flip-Flops, Resettable Latches and Flip Flops, Enabled Latches and Flip Flops.

Unit–V:	**No. of Lectures: 09 Hours**	

VHDL:-Behavioral Modeling With Concurrent Signal Assignments. Bitwise Operators. Comments and white space. Other Operator. Conditional Signal Assignment Statements, Selected Signal Assignment Statements. Basic Constructs: Blocks, Entities and Architecture. Hierarchy, Types, Library and Use Clauses. Tri-states

Concerned faculty member should suitably frame SIX Practical's / assignments from the following list

1. Study of MOS Transistor Characteristics.
2. Design and Simulation of CMOS Inverter.
3. Design of CMOS NAND and NOR Gates.
4. Design of Multiplexer Using CMOS Logic.
5. Study of CMOS Fabrication Process.
6. Design of CMOS Latches.
7. Design of CMOS Flip-Flops.
8. VHDL Modelling of CMOS Circuits.

Text Books:

1. N.H.E. Weste and D.M. Harris, CMOS VLSI design: "A Circuits and Systems Perspective" 4th Edition, Pearson Education India, 2011.
2. N.H.E. Weste and Kamran Eshraghian , "Principles of CMOS VLSI Design, A Systems Perspective," 4th Edition, Pearson Education India, 2011

Reference Books:

1. P. Allen and D. Holberg "CMOS Analog Circuit Design", Oxford University Press.
2. B. Razavi "Design of Analog CMOS Integrated Circuits", Tata McGraw-Hill.
3. P. Gray, P. Hurst, S. Lewis and R. Meyer "Analysis and Design of Analog Integrated Circuits", Wiley Sons.

NPTEL LINK:

1. VLSI Circuits by Prof. Srinivasan, IIT Madras
   https://nptel.ac.in/courses/117106092
2. Digital Systems Design by Prof. D. Roy choudhury IIT Kharagpur
   https://nptel.ac.in/courses/117105080

Guide lines for ICA:

Students must submit ICA in the form of journal. Each assignment should be well documented. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.

Guidelines for ESE:

ESE will be based on drawing/assignment submitted by the student in the form of journal. Evaluation will be based on oral, paper work and performance in the ESE.

ANTENNA THEORY LAB (PEC-II)				
LAB COURSE CONTENT				
ANTENNA THEORY LAB	**Semester:**	**VI**	**Course Code:**	**EC – 605B**

Course description:-This course introduces antenna fundamentals, focusing on radiation mechanisms, antenna parameters, and performance metrics such as radiation pattern, directivity, gain, bandwidth, polarization, efficiency, and impedance. Mathematical tools including radiation integrals and vector potentials are developed to analyze antenna radiation in the far field. This course also equips students with both theoretical foundations and practical insights necessary for the analysis, design, and application of antennas in wireless communication, radar, broadcasting, satellite, and microwave systems

Prerequisite course(s):
Knowledge of basic Electrical and Electronics Engineering and its concept.

Teaching Scheme:

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03
Practical	04	15	60	**02**

Theory	**3 hours/week**	**End semester exam (ESE) :UA OR**	**25 marks**
Practical:	**4 hours/week**	**Internal Continuous Assessment (ICA): CA**	**50 marks**
Semester Credits	**05**		
End Semester Exam (ESE) Pattern:		**Oral (OR)**	

Course objectives:

1. To understand the applications of electromagnetic engineering.
2. To analyze and understand the Uniform plane wave propagation in various media.
3. To solve the electric field and magnetic fields for a given wire antenna.
4. To formulate and solve the Helmholtz wave equation and solve it for Uniform Plane Wave.
5. To understand antenna array and its radiation characteristics.

Course outcomes:

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

1. Students will describe the mathematical concepts of antenna theory and its analysis.
2. Formulate the wave equation and solve it for uniform plane wave.
3. Analyze the given wire antenna and its radiation characteristics.
4. Identify the suitable antenna for a given communication system.
5. Analyze the given antenna array and its radiation characteristics

COURSE CONTENT

Theory	**3 hours/week**	**Examination Scheme**	
Practical:	**4 hours/week**	**End semester exam (ESE): UA OR**	**25 marks**
		Internal Continuous Assessment (ICA): CA	**50 marks**
End Semester Exam (ESE) Pattern:		**Oral (OR)**	
Unit–I:		**No. of Lectures: 09 Hours**	

Uniform Plane Waves: Maxwell Equations in phasor form, Wave Equation, Uniform Plane wave in Homogeneous, free space, dielectric, conducting medium. Polarization: Linear, circular & Elliptical polarization, unpolarized wave. Reflection of plane waves, Normal incidence, oblique incidence, Electromagnetic Power and Poynting theorem and vector.

Unit–II:	**No. of Lectures: 09 Hours**	

Antenna Fundamentals : Introduction, Types of Antenna, Radiation Mechanism, Antenna Terminology: Radiation pattern, radiation power density, radiation intensity, directivity, gain, antenna efficiency, half power beam width, bandwidth, antenna polarization, input impedance, antenna radiation stable and unstable efficiency, effective length, effective area, reciprocity. radiation Integrals: Vector potentials A, J, F, M, Electric and magnetic fields electric and magnetic current sources, solution of inhomogeneous vector potential wave equation, far field radiation.

Unit–III:	**No. of Lectures: 09 Hours**	

Wire Antennas: Analysis of Linear and Loop antennas: Infinitesimal dipole, small dipole, and finite length dipole half wave length dipole, small circular loop antenna, Complete Analytical treatment of all these elements.

Unit–IV:	**No. of Lectures: 09 Hours**	

Antenna Arrays: Two element array, pattern multiplication N-element linear array, uniform amplitude and spacing, broad side and end-fire array, N-element array: Uniform spacing, nonuniform amplitude, array factor, binomial and Dolph Tchebyshev array, Planar Array, Circular Array, Log Periodic Antenna, Yagi Uda Antenna Array.

Unit–V:	**No. of Lectures: 09 Hours**	

Antennas and Applications: Structural details, dimensions, radiation pattern, specifications, features and applications of following Antennas: Hertz & Marconi antennas, V- Antenna, Rhombic antenna. TW antennas. Loop antenna, Whip antenna, Biconical, Helical, Horn, Slot, Microstrip, Turnstile, Super turnstile & Lens antennas. Antennas with parabolic reflectors.

Concerned faculty member should suitably frame SIX Practical's / assignments from the following list

1. To determine radiation pattern, beam width, gain, polarization, and input impedance of a half-wave dipole antenna.
2. To experimentally verify Friis transmission equation and study the relation between gain, effective aperture, and received power.
3. To study radiation pattern and directivity of a two-element/three-element linear antenna
   array with uniform spacing and excitation.
4. To study radiation characteristics of loop antenna and compare its performance with dipole antennas.Measurement of coupling factor and directivity of Directional coupler.
5. To measure beam width, gain, and radiation pattern of sectorial/pyramidal horn antenna.Measurement of VSWR (using Vmax / Vmin method).
6. To study frequency-independent characteristics and radiation pattern of log-periodic Antenna.
7. To design and analyze a rectangular microstrip antenna for a given frequency using analytical formulas/simulation tools.
8. To experimentally determine VSWR, bandwidth, radiation pattern, and efficiency of a microstrip antenna.

Text Books:

1. C. A. Balanis, "Antenna Theory and Design", 3rd Ed., John Wiley & Sons., 2005.
2. K.D. Prasad "Antennas And Wave Propagation" Satya Prakashan, Tech India. Publications.

Reference Books:

1. Harish A. R., Antenna and wave propagation, Oxford University Press. Tri T. Ha, "Digital Satellite Communications", Tata McGraw-Hill,2009
2. J.D.Kraus, "Antennas", McGraw-Hill,1988

NPTEL LINK :

1. Fundamentals of Antennas, by Prof. Girish kumar, IIT Bombay, https://www.youtube.com/watch?v=1J_iDY1CEk0&t=15 2. Electromagnetic Fields & Waves by Prof. Prof. R. K. Shevgaonkar, IIT Bombay, https://www.youtube.com/playlist?list=PLbMVogVj5nJTY9cV2w1z8O0jL9JZ8b5M0
Guide lines for ICA:
Students must submit ICA in the form of journal. Each assignment should be well documented. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.
Guidelines for ESE:
ESE will be based on drawing/assignment submitted by the student in the form of journal. Evaluation will be based on oral, paper work and performance in the ESE.

ROBOTICS & AUTOMATION LAB (PEC-II)				
LAB COURSE CONTENT				
ROBOTICS & AUTOMATION LAB	**Semester:**	**VI**	**Course Code: RAL**	**EC – 605C**

Course description: - This course introduces the fundamentals of robotics, including its historical development, classifications, and core principles such as robot configurations, components, and coordinate systems. It explores industrial applications across sectors like manufacturing, healthcare, defense, and automation, highlighting real-world robotic processes.

Prerequisite course(s):
Basic knowledge of Physics, Electronics and Computer programming.

Teaching Scheme:

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03
Practical	04	15	60	02

Course objectives:

1. Familiarize the students with the basic principles of Robotics.
2. Introduce the various Parts of Robots and Fields of Robotics.
3. Acquaint the students with the knowledge of applications of Robotics.
4. Prepare the students for understanding Planning and control in Robotics.
5. Understand the socio-economic aspects of Robotics.

Course outcomes:

After successful completion of this course the student will be able to:
1. Understand basics of Robotics, types, classification and methodology.
2. Acquire the skills in understanding principles of Robotics.
3. Develop skills in understanding industrial Robotics.
4. Explain Planning and control in Robotics.
5. Learn Socio-economic aspects of Robotics.

COURSE CONTENT

Theory	**3 hours/week**	**Examination Scheme**	
Practical:	**4 hours/week**	**End semester exam (ESE): UA OR**	**25 marks**
		Internal Continuous Assessment (ICA): CA	**50 marks**
End Semester Exam (ESE) Pattern:	**Oral (OR)**		
Unit–I:		**No. of Lectures: 09 Hours**	

Introduction of Robotics:-Historical development of Robotics, Definitions of Industrial Robot, Type and Classification of Robots, Asimov's laws of robotics, Methodology of robotics.

Unit–II:	**No. of Lectures: 09 Hours**	

Principles of Robotics:- Robot configurations, Robot Components, Robot Degrees of Freedom, Work volume and work envelope, Robot Joints and symbols, Robot Coordinates, Robot Reference Frames, Resolution, accuracy and precision of Robot, Work cell control.

Unit–III:	**No. of Lectures: 09 Hours**	

Industrial Applications of Robotics:- Introduction of processes like Coating, Deburring, cleaning, Die Casting, Molding, Material handling, Picking, Palletizing, Packaging, hospitals and patient care, sports and recreation, defense and surveillance industry, home automation, mining industry.

Unit–IV:	**No. of Lectures: 09 Hours**	

Planning and control in Robotics:-Trajectory planning, position control, force control, Robot programing methods, hybrid control, Industrial and medical robotics: application in manufacturing processes.

Unit–V:	No. of Lectures: 09 Hours	

Socio-economic aspects of Robotics:- A robot-based manufacturing system, robot cell design considerations and selection of robot, Robot Economics, Functional Safety in Robotic Application.

Concerned faculty member should suitably frame SIX Practical's / assignments from the following list.

1. Study and analysis of robot grippers (includes the problems based on gripper force).
2. Demonstration of various robotic configurations using industrial robot.
3. MATLAB program for simple kinematics of simple robot configuration.
4. MATLAB program for inverse kinematics of simple robot configuration.
5. To demonstrate simple robotic system using MATLAB.
6. Study of configuration of robots and motion of robot manipulator.
7. Study of pick and place industrial robot.
8. One Industrial visit for Industrial robotic application.

Text Books:

1. Dr. Manoj S. Gelli "Robotics and Automation ", Pen and Paper Academy. Edition August 2025.
2. J.J.Craig"Introduction to Robotics Mechanics & Control", Pearson Education, 3rd Edition, 2014.
3. M.P.Groover,"Automation, Production Systems & Computer Integrated Manufacturing", PHI, 3rd Edition, 2018

Reference Books:

1. 1.Fundamentals of Robotics by D.K. Pratihar, Narosa Publishing House, New-Delhi, 2017
2. K.S. Fu, R.C. Gonzalez, C.S.G. Lee "Robotics", McGraw-Hill Book Company, 1987
3. J.G. Keramas, "Robotics Technology Fundamentals", Thompson Learning, 2nd Edition, 2016

NPTEL LINK :

1.Robotics By Prof. Dilip Kumar Pratihar IIT Kharagpur
https://onlinecourses.nptel.ac.in/noc19_me74/preview

2. Introduction to robotics By Prof. Asokan T, Prof. Balaraman Ravindran, Prof. Krishna Vasudevan IIT Madras.
https://onlinecourses.nptel.ac.in/noc20_de11/preview

Guide lines for ICA:

Students must submit ICA in the form of journal. Each assignment should be well documented. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.

Guidelines for ESE:

ESE will be based on drawing/assignment submitted by the student in the form of journal. Evaluation will be based on oral, paper work and performance in the ESE.

ELECTROMAGNETIC WAVES (PEC-III)					
COURSE OUTLINE					
Course Title:	**ELECTROMAGNETIC WAVES**	**Short Title:**	**EMW**	**Course Code:**	**EC-606 A**
Course description:-Electromagnetic waves is an important fundamental course with great academic relevance progress in this exciting theory has made possible the advent of many technologies, such as optical fiber communications, wireless communication, antennas and wave propagation, micro wave engineering, etc. Interference and electrical noise problems that affect industry can also be better understood and their solutions can be provided using field theory.					
	Hours/week	**No. of weeks**	**Total hours**		**Semester credits**
Theory	03	15	45		03
Prerequisite course(s):					
Engineering mathematics such as vector calculus, vector point functions, derivative etc. Basic Electrical Engineering.					
Course objectives:					
1. To study the basics of Electrostatics and Magneto-statics with their applications. 2. To learn the boundary condition particularly a boundary between conducting material and free space. 3. To understand the Time Varying Fields and Maxwell's Equations. 4. To interpret the given electromagnetic problem and solve it using Maxwell's Equations. 5. To analyze the wave propagation in different media using wave equation**.**					
Course outcomes:					
After successful completion of this course the student will be able to:					
1. To apply fundamental knowledge to learn the basic laws of electromagnetism. 2. To analyze the electric & magnetic fields for simple configurations under static conditions. 3. To analyze time varying electric and magnetic fields. 4. To describe the Maxwell's equation in different forms and different media. 5. To describe the propagation of EM waves.					
COURSE CONTENT					
ELECTROMAGNETIC WAVES		**Semester:**		**VI**	
Teaching Scheme:		**Examination scheme**			
Lectures:	**3hours/week**	**End semester exam (ESE):UA**	**60 marks**		
		Duration of ESE:	**03 hours**		
		Internal Sessional Exams (ISE):CA	**40 marks**		
Unit–I:		**No. of Lectures: 09 Hours**		**Marks: 12**	
Basic Electrostatics:-Review of vector Analysis and coordinate systems. Coulomb's force law & Numerical based on force law. Concept of electric field intensity, Line Charge density, Electric field due to point charge, Numerical based on different configuration of charges. Concept of Electric Flux. Relation between flux density & electric field intensity.					
Unit–II:		**No. of Lectures: 09 Hours**		**Marks: 12**	
Gauss's law, Energy and Potential: - Gauss's law, Application of Gauss's law to symmetrical charge distribution. Divergence Theorem. Work Done, Concept of Potential & Potential					

Difference, Potential difference in field of point & Line.		
Unit–III:	**No. of Lectures: 09 Hours**	**Marks:12**
Applied Electrostatics:-Current and current density, Current continuity equation. Properties of conductors and dielectric materials. Boundary Condition, between conductor and free space, between conductor and dielectric and between two perfect Dielectric materials, Capacitance, Parallel plate capacitor, Calculation of capacitance of spherical capacitor.		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks:12**
Magneto-statics: - Magneto statics- Biot- Savart's law, Magnetic field due to finite, infinitely and circular loop Current carrying Conductor, Ampere's Circuital law, Point form of Ampere's circuital Law/Curl operator. Stokes theorem, Magnetic flux & Magnetic flux density.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks:12**
Time Varying Fields & Uniform Plane Waves:- Maxwell's equations (Differential, Integral and Phasor forms) for time varying, Static & free space. Uniform plane waves, Representation of wave equation in free space. Representation of wave motion in perfect dielectrics and Lossy dielectrics. Poynting's theorem & Wave power.		
Text Books: 1. William H. Hayt, J A Buck "Engineering Electromagnetics"-, Tata McGraw Hill Publication 7th Edition. 2. K. D. Prasad – "Antenna and Wave Propagation", Satya Prakashan.		
Reference Book		
1. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Publication, 2014. 2. R K Shevgaonkar, "Electromagnetic Waves", 1st Edition, Tata McGraw Hill		
NPTEL LINK : **1**. Electromagnetic Theory by Pradeep Kumar K, IIT Kanpur https://nptel.ac.in/courses/108104087 2. Introduction to Electromagnetic Theory by Prof. Manoj Harbola IIT Kanpur. https://nptel.ac.in/courses/115104088		

ELECTROMANETIC WAVES LAB (PEC-III)					
LAB COURSE CONTENT					
Course Title:	**ELECTROMANETIC WAVES LAB**	**Short Title:**	**EMWL**	**Course Code:**	**EC-607A**
Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**	
	2	**15**	**30**	**1**	

LAB COURSE CONTENT			
ELECTROMANETIC WAVES LAB		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Practical:	**2hours/week**	**Internal Continuous Assessment (ICA): CA**	**25Marks**

Concerned faculty member should suitably frame SIX laboratory assignments from following list.

1. Verification of Coulomb's Law (Simulation Based).
2. Study of Electric Field Intensity for Different Charge Configurations.
3. Verification of Gauss's Law for Symmetrical Charge Distributions.
4. Determination of Capacitance of Parallel Plate Capacitor.
5. Calculation of Capacitance of Spherical Capacitor (Simulation/Analytical).
6. Verification of Biot–Savart Law.
7. Verification of Ampere's Circuital Law.
8. Study of Maxwell's Equations and Uniform Plane Wave Propagation.

Guidelines for ICA:

Students must submit ICA in the form of a journal. Each experiment should be well documented. The faculty in charge will assess the experiments continuously and grade or mark each experiment on the completion date declared for each experiment.

EMBEDDED SYSTEM AND RTOS (PEC– III)

COURSE OUTLINE

Course Title:	EMBEDDED SYSTEM AND RTOS	Short Title:	ESR	EC– 606 B

Course description:

This is a core course which gives the detailed knowledge of Embedded Systems. It gives the introduction to embedded systems. It also gives the exposure of assembly language programming for ARM Processor and Embedded C programming for ARM LPC 2148 Microcontroller.

Lecture	Hours/week	No. of weeks	Total hours	Semester credits
	03	15	45	03

Prerequisite course(s):

Basics of Microprocessors & Microcontrollers, Knowledge of C programming.

Course objectives:

1. To understand the characteristics of embedded systems and its Architectures.
2. To learn architecture of ARM processors and its versions.
3. To study key features of Microcontroller LPC2148.
4. To provide skills in embedded C programming & interfacing with Processor.
5. To understand the concept of real time operating systems.

Course outcomes:

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

1. Distinguish real-time embedded systems from other systems.
2. Understand the ARM processor architecture and its version.
3. Demonstrate the use of on chip resources of LPC 2148.
4. Design Real World Interfacing with ARM7 Based Microcontroller applications.
5. Apply the concepts of RTOS in an embedded system design.

COURSE CONTENT

EMBEDDED SYSTEM AND RTOS		Semester:	VI
Teaching Scheme:		Examination scheme	
Lectures:	3 hours/week	End semester exam(ESE):UA	60 marks
		Duration of ESE:	03 hours
		Internal Sessional Exams (ISE):CA	40 marks

Unit–I:	No. of Lectures:09 Hours	Marks:12

Embedded System Introduction:-Definition, Embedded Systems Vs. General Computing Systems, Classification, categories, Characteristics, Recent Trends, quality attributes (design Metric), embedded product development life cycle (EDLC).

Unit–II:	No. of Lectures: 09 Hours	Marks: 12

Introduction to ARM Processors:-Introduction to ARM processors and its versions, ARM7, ARM9 & ARM11 features advantages suitability in embedded application. Introduction to Tiva TM4C123G Series Overview, Programming model, Tivaware Library.

Unit–III:	No. of Lectures: 09 Hours	Marks: 12

ARM Processors:-
ARM7: registers, CPSR, SPSR, ARM & RISC design philosophy, ARM7 dataflow model, Programmers model, modes of operations.
ARM7 Based Microcontroller LPC2148: Features, Architecture (Block Diagram and Its Description), System Control Block (PLL and VPB divider) Memory Map, GPIO, timer.

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**

Real World Interfacing with ARM7 Based Microcontroller:-
Programming in assembly language/ Embedded C, Interfacing with LED, LCD, GLCD, KEYPAD, stepper / dc motor, simple LPC2148 GPIO Programming examples Using timers of LPC2148 to generate delay.

Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**

Real Time Operating System (RTOS):-
Types of OS, Tasks, process, Threads, Multiprocessing and, Multitasking, Task scheduling, Threads, Process, Scheduling, Task communications, Task synchronization, how to choose RTOS, Overview of operating system (off-the-shelf, Embedded, RTOS, Handheld).

Text Books:

1. Raj Kamal, “Embedded Systems”, TMH, 2008.
2. Shibu. K.V, “Introduction to Embedded Systems”, TMH, 2009.

Reference Books:

1. Frank Vahid – “Embedded Systems”, Wiley India, 2002
2. Jean J Labrose – “MicroC / OS-II”, Indian Low-Price Edition 2002
3. Dr.K.V.K.K. Prasad – “Embedded / real time system”, Dream tech
4. Iyer, Gupta – “Embedded real systems Programming”, TMH

NPTEL Links:

1. Embedded System Design with ARM by Prof. Indranil Sengupta ,Prof. Kamalika Datta, IIT Kharagpur.
https://nptel.ac.in/courses/106105193.
2. Real Time Operating System, By Prof. Rajib Mall, IIT Kharagpur.
https://nptel.ac.in/courses/106105172.

EMBEDDED SYSTEM AND RTOS LAB (PEC– III)					
LAB COURSE CONTENT					
Course Title:	**Embedded System and RTOS Lab**	**Short Title:**	**ESR L**	**Course Code:**	**EC-607 B**
Course description:					
This is a core course gives the practical as well as interfacing knowledge of Embedded Systems. It gives the practical exposure of C language programming for ARM Processor and Embedded C programming for ARM LPC 2148 Microcontroller.					

Laboratory	**Hours/week**	**No.of weeks**	**Total hours**	**Semester credits**
	2	15	30	1

LAB COURSE CONTENT			
Embedded System And RTOS Lab		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**		
		Internal Continuous Assessment (ICA) :CA	**25 marks**

Concerned faculty member should suitably frame SIX laboratory experiments from the following list.

1. Writing basic C-programs for I /O operations.
2. C-Program to explore timers/counter.
3. ProgramtodemonstrateI2CProtocol.
4. Program to demonstrate CAN Protocol.
5. Program to interface LCD.
6. Program to interface stepper motor.
7. Implementation of USB protocol and transferring data to PC.
8. Interfacing 4X4 matrix keyboard and 16x2 characters LCD Display to microcontroller.

Guidelines for ICA:

Students must submit ICA in the form of a journal. Each experiment should be well documented. The faculty in charge will assess the experiments continuously and grade or mark each experiment on the completion date declared for each experiment.

AUDIO & SPEECH PROCESSING (PEC-III))					
COURSE OUTLINE					
Course Title:	**AUDIO & SPEECH PROCESSING**	**Short Title:**	**ASP**	**Course Code:**	**EC-606 C**

Course description:-
Basic properties of audio and speech signals, Basic concepts and operations of audio signal processing, Introduction to acoustics and hearing; Processing of digital audio signals, equalization, perceptual audio coding, sound synthesis.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03

Prerequisite course(s):

Signals & Systems, Digital Signal Processing

Course objectives:

1. To be able to relate human physiology and anatomy with signal processing paradigms.
2. To acquire the knowledge of speech generation and speech recognition models.
3. To understand methods/techniques used in speech signal estimation &detection.
4. To understand various speech coding techniques.
5. To acquire applications of speech processing.

Course outcomes:

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

1. Mathematically model the speech signal.
2. Analyze the quality and properties of speech signal.
3. Modify and enhance the speech and audio signals.
4. Summarize the various speech coding techniques.
5. Analyze application of speech processing in speech compression, speech recognition, and speech synthesis.

COURSE CONTENT			
		Semester:	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):UA**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):CA	**40 marks**
Unit–I:		**No. of Lectures: 09 Hours**	**Marks: 12**

Speech Production and Modeling Human Auditory System; General structure of speech coders The process of speech production, Acoustic theory of speech production, Digital models of speech signals of speech signal.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Time and frequency domain analysis of speech, Linear predictive coding (LPC) analysis, Cepstral analysis, Speech parameter (pitch) estimation. Speech Signal Processing.

Unit–III	**No. of Lectures: 09 Hours**	**Marks:12**
Principles of speech synthesis, Generic CELP encoders and decoders. Excitation code book search-state save method, zero-input zero state method .CEPL based on adaptive codebook, Adaptive codebook search.		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks:12**
Introduction ,Scalar Quantization, uniform quantizer, logarithmic quantizer, adaptive quantizer Speech redundancies, Vector quantization-distortion measures, code book design, code book types., Linear delta modulation, Adaptive delta modulation,		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks:12**
Digital Audio, Lossy sound compression, μ- law and A-law companding, DPCM and ADPCM audio compression, MPEG audio standard, frequency domain coding, format of compressed data.		
Text Books		
1. A .M. Kondoz "Digital Speech," Second Edition (Wiley Students Edition), 2004. 2. W. C. Chu "Speech Coding Algorithms: Foundation and Evolution of Standardized Coders", Wiley Inter science, 2003.		
Reference Books:-		
1. Thomas F. Quatieri "Discrete-Time Speech Signal Processing: Principles and Practice", Publisher: Prentice Hall. 2. Nelson Morgan and Ben Gold "Speech and Audio Signal Processing: Processing and Perception of Speech and Music", John Wiley & Sons. 3. Gold & Morgan "Speech and Audio Signal Processing",1999,Wiley and Sons		
NPTEL LINK : 1. Prof. Shyamal Kumar Das Mandal, IIT Kharagpur https://nptel.ac.in/courses/117105145 2.Prof. Mrityunjoy Chakraborty,IIT Kharagpur https://onlinecourses.nptel.ac.in/noc25ee120/preview		

AUDIO & SPEECH PROCESSING LAB (PEC-III)					
LAB COURSE CONTENT					
Course Title:	**AUDIO & SPEECH PROCESSING LAB**	**Short Title:**	**ASPL**	**Course Code:**	**EC-607 C**

Course description:

This is a course gives the practical as well as knowledge about Audio & Speech processing and audio compression techniques ,analysis of speech signal & speech synthesis.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	2	15	30	1

LAB COURSE CONTENT			
Audio & speech Processing LAB		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**		
		Internal Continuous Assessment (ICA) :CA	**25 marks**

Concerned faculty member should suitably frame SIX laboratory experiments from following list.

1. Speech Signal Recording and Time Domain Analysis.
2. Frequency Domain Analysis of Speech Signal.
3. Linear Predictive Coding (LPC) Analysis.
4. Cepstral Analysis of Speech Signal.
5. Pitch Estimation of Speech Signal.
6. Speech Synthesis Using Basic Model / CELP Concept.
7. Quantization and Delta Modulation.
8. Audio Compression Techniques

Guide lines for ICA:

Students must submit ICA in the form of journal. Each experiment should be well documented. Faculty in charge will assess the experiments continuously and grade or mark each experiment on completion date declared for each experiment.

DIGITAL IMAGE PROCESSING (MD M)					
COURSE OUTLINE					
Course Title:	**Digital Image Processing**	**Short Title:**	**DIP**	**Course Code:**	**EC-608**

Course description: In this course students will learn digital image processing fundamentals which include image acquisition, representation, image transforms, image enhancement, image smoothing and sharpening, image segmentation.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	02	15	30	02

Prerequisite course(s):

Digital Electronics and Basic of probability theory.

Course objectives:

1. To study the fundamental concept of digital Image Processing
2. To understand the principle of spatial domain for representation of image.
3. To learn Image Enhancement in Spatial Domain.
4. To understand working of spatial filter
5. To study and understand operation of image segmentation.

Course outcomes:

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

1. Understand fundamental concept and application digital Image Processing
2. Apply the spatial domain transformation for representation of image
3. Explain the image enhancement using Gray Level Transformations, Histogram Processing.
4. Apply spatial filters for Smoothing image.
5. Apply point, line and edge detection for Image segmentation.

COURSE CONTENT

Digital Image Processing		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**2 hours/week**	**End semester exam (ESE): UA**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):CA	**40 marks**
		Internal Continuous Assessment (ICA) :CA	**25 marks**

Unit–I:	**No. of Lectures: 06 Hours**	**Marks: 12**

Digital Image Fundamentals:-Introduction, Examples of Fields that use Digital Image Processing, Fundamental Steps in Digital Image Processing, Components of Image Processing Systems, Image Sensing and Acquisition, Image Sampling and Quantization.

Unit–II:	**No. of Lectures: 06 Hours**	**Marks: 12**

Representation of Digital Images:-Representing Digital Images, Spatial and Gray level Resolution, Basic pixel relationship, Distance Measures, Statistical Properties, Histogram, Mean, Standard Deviation

Unit–III	**No. of Lectures: 06 Hours**	**Marks:12**

Image Enhancement in Spatial Domain:-Enhancement in Spatial Domain: Basic Gray Level Transformations, Histogram Processing, Enhancements using arithmetic and logical operations.		
Unit–IV:	**No. of Lectures: 06 Hours**	**Marks:12**
Spatial Filters:-Smoothing spatial filters: smoothing linear, order statistic filters sharpening, spatial filters: Use of first derivatives and second derivatives for enhancement.		
Unit–V:	**No. of Lectures: 06 Hours**	**Marks:12**
Image Segmentation and Edge Detection:-Image Segmentation: Point, line, Edge detection, Canny Edge Detection, Second Order Derivative, Region Based Segmentation, Region Growing, Region Splitting and Merging.		
Text Books:		
1. Rafael C. Gonzalez and Richard E. Woods, "Digital image processing", (Pearson Education Publication). 2. A. K. Jain - Digital Image Processing, PHI publication.		
Reference Books:		
1. Arthur Weeks Jr. – "Fundamentals of Digital Image Processing," PHI publication. 2. Pratt – "Digital Image Processing", Wiley Publication 3. Castleman – "Digital Image Processing", Pearson publication.		
NPTEL LINK : 1. Digital Image Processing, by Prof. Prabir Kumar Biswas IIT Khragpur. https://nptel.ac.in/courses/117105135. 2. Computer Vision and Image Processing - Fundamentals and Applications by Prof. M. K. Bhuyan IIT Guwahati. https://onlinecourses.nptel.ac.in/noc26_ee31/preview		
Concerned faculty member should suitably frame SIX assignments from the following list. 1. Steps in image processing. 2. Application areas of image processing. 3. Image sensing & Acquisition. 4. Image Sampling & quantization. 5. Basic relationship between pixels. 6. Gray level transformation. 7. Histogram Equalization. 8. Histogram Matching. 9. Smoothing & sharpening filter. 10. Edge detection. 11. Image Segmentation.		
Guidelines for ICA:		
Students must submit ICA in the form of journal. Each assignment should be well documented. Faculty in Charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.		

FAULT FINDING IN PCB (VSEC)				
LAB COURSE CONTENT				
FAULT FINDING IN PCB	**Semester:**	**VI**	**Course Code:**	**EC -609**

Course description:

This laboratory course provides practical training in identifying, diagnosing, and repairing faults in printed circuit boards (PCBs) using standard test instruments and systematic troubleshooting methods. Students develop skills in component testing, fault isolation, power supply and digital circuit troubleshooting, and PCB repair through soldering and rework techniques.

Teaching Scheme:

	Hours/week	No. of weeks	Total Hours	Semester Credits
Theory	**01**	**15**	**15**	**01**
Practical:	**02**	**15**	**30**	**01**
			Examination Scheme	
			Internal Continuous Assessment (ICA):CA	**25 Marks**

Course objectives:

1. To understand the fundamentals of PCB structure, components, and common fault types.
2. To develop skills in using electronic test instruments such as multimeters, CRO, and function generators for troubleshooting.
3. To train students in systematic fault identification and isolation techniques in analog and digital circuits.
4. To provide hands-on experience in PCB repair through soldering, desoldering, and rework practices.
5. To emphasize safety measures, ESD protection, and preventive maintenance in handling electronic circuits.

Course outcomes:

After successful completion of this course the student will be able to:
Identify different types of faults in PCBs such as open circuits, short circuits, and component failures.

1. Use standard electronic test instruments effectively for diagnosing circuit faults.
2. Apply systematic troubleshooting techniques to locate and isolate faults in analog and digital circuits.
3. Perform PCB repair using proper soldering, desoldering, and rework methods.
4. Follow safety practices, including ESD protection, while working with electronic systems.

Concerned faculty member should suitably frame Six laboratory experiments / assignments from following list.

1. Study of PCB Layout and Component Identification
2. Continuity Testing of PCB Tracks
3. Detection of Short Circuits and Solder Bridges
4. Testing Passive Components In-Circuit
5. Testing Semiconductor Devices on PCB
6. Cold Solder Joint and Dry Solder Fault Detection
7. Signal Tracing Using CRO or Logic Probe
8. IC Fault Identification and Replacement

Guide lines for ICA:

Students must submit ICA in the form of journal. Each experiment / assignment should be well documented. Faculty in charge will assess the experiments / assignments continuously and grade or mark each experiment / assignment on completion date declared for each experiment / assignment.

Kavayitri Bahinabai Chaudhari
NORTH MAHARASHTRA UNIVERSITY,
JALGAON (M.S.)

Bachelor of Engineering – **Honors**
in
5G & Advance Technology
for Third Year Bachelor of Engineering
in
Electronics &Telecommunication
(As per NEP 2020 Guidelines)

Faculty of Science and Technology

'A' Grade
NAAC Re-Accredited
(4th Cycle)

SYLLABUS STRUCTURE & COURSE OUTLINE
For Affiliated Colleges
Semester – V & VI
W.E.F. 2026 – 27

Syllabus Structure for Honors in 5G and Advance Technology: Additional Credit (Semester – V) (w.e.f. 2026 – 27) (As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ET -510A	Microwave Engineering	PCC	3			3	40	60			100	3
ET -511A	Microwave Engineering Lab	PCC			2	2			25	25 (OR)	50	1

Syllabus Structure for Honors in 5G and Advance Technology: Additional Credit (Semester – VI) (w.e.f. 2026 – 27) (As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ET -612A	Antenna and Wave Propagation	PCC	3			3	40	60			100	3
ET -613A	Antenna and Wave Propagation Lab	PCC			2	2			25	25 (OR)	50	1

MICROWAVE ENGINEERING (PCC) (Honors)					
COURSE OUTLINE					
Course Title:	**MICROWAVE ENGINEERING**	**Short Title:**	**ME**	**Course Code:**	**ET-510A**

Course description:

This course is designed to lay the foundation of microwave theory. The various modes of propagation's through wave guides are included. Students will become familiar with the usage of active and passive components of microwave systems. Measurements of various parameters of microwave systems and Modern trends of microwave engineering.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03

Prerequisite course(s):

Electromagnetic theory, Wave propagation, Antennas and Semiconductor physics.

Course objectives:

1. To study the basics concept of various mode of propagation in waveguide.
2. To Understand the fundamentals of microwave passive components.
3. To familiarize the concept of microwave active devices.
4. Provide strong foundation for understanding of microwave measurement and microwave Antenna.
5. To Learn the modern trends in microwave Engineering.

Course outcomes:

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

1 Describe the basic concepts and applications of microwave systems.
2. Analyse, test and use various passive microwave components for different applications.
3. Describe the concept of microwave active tubes.
4. Apply the concept for measurement of various parameters of microwave system.
5. To describe the modern trends in microwave engineering.

MICROWAVE ENGINEERING

COURSE CONTENT

MICROWAVE ENGINEERING		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):UA**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):CA	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction to Microwaves: Microwave frequency range: **-1 GHz – 300 GHz,** Microwave vs RF: Lumped circuits fail → distributed parameters**,** Advantages: large bandwidth, high data rate, Applications: radar, satellite, mobile, medical, industrial heating, Microwave spectrum bands: L, S, C, X, Ku, K, Ka (Numerical expected).

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Transmission Line Theory Types:- coaxial, two-wire, strip line, micro-strip, **Primary constants**: R, L, G, C, **Secondary constants**: Characteristic impedance (Z_0), Propagation constant (γ), Standing waves, **VSWR**, reflection coefficient, Lossless & low-loss lines,

Impedance matching basics (Numerical expected).		
Unit–III	**No. of Lectures: 09 Hours**	**Marks:12**
Waveguides: Rectangular & circular waveguides, Modes: **TE, TM, TEM,** Cut-off frequency, Dominant mode: $\mathbf{TE_{10}}$, Phase velocity > c, group velocity < c, Power transmission in waveguides. **Cavity Resonators**: Waveguides with shorted ends, Acts as **LC resonant circuit,** Resonant frequency calculation, Quality factor (Q): Unloaded, loaded, external Q, Applications: oscillators, filters (Numerical expected).		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks:12**
Microwave Components: Passive components: E-plane & H-plane tees, Magic tee, Directional coupler, Isolator & circulator, Scattering parameters (S-parameters), Power divider & attenuators Microwave Tubes: **O-type**: Klystron, TWT, **M-type**: Magnetron, Klystron: velocity modulation → bunching, TWT: wide bandwidth, Magnetron: high power, (Numerical expected)		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks:12**
Modern Trends in Microwaves Engineering Effect of Microwaves on human body, Medical and Civil applications of microwaves, Electromagnetic interference / Electromagnetic Compatibility (EMI / EMC), Monolithic Microwave IC fabrication, RF MEMS for microwave components. **Microwave Systems:-**Wireless Communications system, Radar Systems, Radiometer Systems.		
Text Books:		
1. Samuel Liao, Microwave Devices and Circuits, Pearson Education, Third edition. 2. Annapurna Das, Sisir Das, Microwave Engineering, TMH, Third edition.		
Reference Books:		
1. Robert E Collin, “Foundations for Microwave Engineering”, Wiley India, Second Edition. 2. Sisodia, Gupta,"Microwaves: Introduction to Circuits, Devices and Antennas”, New Age Publication. 3. Manojit Mitra, “Microwave Engineering”, Dhanpat Rai, Third edition.		
NPTEL LINK : 1. Design Principles of Microwave Antennas by Amitabha Bhattacharya, Analysis and IIT Kharagpur. https://youtu.be/h51mFbIgZRI?si=vIJWH9WRH3POyrZs 2. Microwave Theory and Techniques by Prof. Girish Kumar, IIT Bombay. https://onlinecourses.nptel.ac.in/noc20_ee63/preview?utm_source .		

MICROWAVE ENGINEERING LAB (PCC) (HONORS)					
LAB COURSE CONTENT					
Course Title:	**MICROWAVE ENGINEERING LAB**	**Short Title:**	**MEL**	**Course Code:**	**ET-511A**

Course description:

This course is designed to provide hands-on experimental exposure to microwave engineering concepts essential for understanding high-frequency communication systems. The course introduces students to microwave frequency bands, waveguide structures, and propagation mechanisms**,** enabling them to analyze electromagnetic wave behavior in rectangular and circular waveguides. Experiments focus on the measurement of key waveguide parameters such as cut off frequency, phase and group velocity, guide wavelength, and wave impedance for various modes of propagation (TE, TM, and TEM).

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	2	15	30	1

End Semester Exam (ESE) Pattern	**Oral (OR)**

LAB COURSE CONTENT			
MICROWAVE ENGINEERING LAB		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam(ESE) UA:OR**	**25 marks**
		Internal Continuous Assessment (ICA) :CA	**25 marks**

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. Plot and study V-I Characteristics of GUNN Diode.
2. Plot and study Reflex Klystron Characteristics.
3. Measurement of Attenuation (Fixed and Variable).
4. Measurement of isolation and coupling factor of magic tee.
5. Measurement of coupling factor and directivity of Directional coupler.
6. Measurement of insertion loss and isolation of circulator and isolator.
7. Measurement of VSWR (using Vmax / Vmin method).
8. Measurement of polar pattern and the gain of waveguide horn antenna.

Guide lines for ICA:

Students must submit ICA in the form of journal. Each assignment should be well documented. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignments.

Guide lines for ESE:

ESE will be based on the laboratory assignments submitted by the students in the form of journal. Evaluation will be based on the understanding and execution.

ANTENNA & WAVE PROPAGATION (PCC) (Honors)					
COURSE OUTLINE					
Course Title:	**ANTENNA & WAVE PROPAGATION**	**Short Title:**	**AWP**	**Course Code:**	**ET-612 A**

Course description:

The objective of this course is to provide an in- depth understanding of modern antenna concepts, and practical antenna design for various applications. The course will explain the theory of different types of antennas used in communication systems.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03

Prerequisite course(s):

The course requires knowledge about Electromagnetic Field Theory, Network Theory / Circuit Theory**,** Signals and Systems (Basic Level)**,** Analog and Digital Communication (Introductory Level)

Course objectives:

1. To study the basics concept of Antenna and Wave Propagation.
2. To understand the principle and radiation pattern of Antenna.
3. To familiarize the concept of Huygens Principle & Babinet Principle.
4. Provide strong foundation for understanding of Smart antennas.
5. To Learn the modern trends in Antenna and Wave Propagation& different modes of radio Propagation used in current practice.

Course outcomes:

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

1. Describe the basic concepts and applications of Antenna systems.
2. Analyze, test and use various types of radiation pattern of antenna.
3. Describe the concept of Huygens Principle & Babinet Principle.
4. Apply the concept for measurement of various parameters of Antennas.
5. To describe the modern trends in different modes of radio propagation & Smart Antennasbenefits used in current practice.

ANTENNA & WAVE PROPAGATION			
COURSE CONTENT			
ANTENNA & WAVE PROPAGATION		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):UA**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):CA	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Antenna Fundamental Concepts-Definitions – Radiation intensity – Directive gain – Directivity – Power gain – Beam width – Band width – Gain and radiation resistance of current element – Half-wave dipole and folded dipole – Reciprocity principle – Effective length and effective area, Relation between gain, effective length and radiation resistance. Physical concept

of radiation, Radiation pattern, near- and far-field regions, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, radiation integrals and auxiliary potential functions.

Unit–II:	No. of Lectures: 09 Hours	Marks: 12

Antenna Arrays, Radiation from Wires and Loops-Antenna array concept, Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes, extension to planar arrays. Infinitesimal dipole, finite-length dipole, linear elements near conductors, dipoles for mobile communication, small circular loop.

Unit–III	No. of Lectures: 09 Hours	Marks:12

Aperture Antennas-Huygens' principle, radiation from rectangular and circular apertures, design considerations, Babinet's principle, Radiation from sectoral and pyramidal horns, design concepts. Broadband Antennas: Broadband concept, Log-periodic antennas, frequency independent antennas.

Unit–IV:	No. of Lectures: 09 Hours	Marks:12

Microstrip Antennas-Concept, Advantages and disadvantages, Basic characteristics of microstrip antennas, feeding methods, methods of analysis, design of rectangular and circular patch antennas.

Unit–V:	No. of Lectures: 09 Hours	Marks:12

Wave Propagation -The basic types of propagation: Ground wave, and sky wave propagation. Sky Wave Propagation: Structure of the ionosphere – Effective dielectric constant of ionized region – Mechanism of refraction – Refractive index – Critical frequency – Skip distance – Effect of earth's magnetic field – Energy loss in the ionosphere due to collisions – Maximum usable frequency – Fading and diversity reception.
Ground Wave Propagation: Attenuation characteristics for ground wave propagation – Calculation of field strength at a distance.

Text Books:

1. C. A. Balanis, "Antenna Theory and Design", 3rd Ed., John Wiley &Sons. 2005.
2. K. D. Prasad "Antennas And Wave Propagation", Satya Prakashan, Tech India Publications.

Reference Books:

1. Harish A. R., Antenna and wave propagation, Oxford University Press. Tri T. Ha, "Digital Satellite Communications", Tata McGraw-Hill,2009
2. J.D.Kraus, "Antennas", McGraw-Hill,1988

NPTEL LINK :

1. RF and Microwave Networks by Prof Bratin Ghosh, IIT Kharagpur, https://nptel.ac.in/courses/108105189
2. Antennas, by Prof Girish Kumar, IIT Bombay, https://onlinecourses.nptel.ac.in/noc20_ee20/preview?utm_source

ANTENNA & WAVE PROPAGATION LAB (PCC)(Honors)					
LAB COURSE CONTENT					
Course Title:	**ANTENNA & WAVE PROPAGATION**	**Short Title:**	**AWPL**	**Course Code:**	**ET-613 A**
	LAB COURSE CONTENT				

Course description:

This course is designed to provide hands-on experimental exposure to microwave engineering concepts essential for understanding high-frequency communication systems. The course introduces students to microwave frequency bands, waveguide structures, and propagation mechanisms**,** enabling them to analyze electromagnetic wave behavior in rectangular and circular waveguides.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	2	15	30	1

End Semester Exam (ESE) Pattern		**Oral (OR)**	
LAB COURSE CONTENT			
ANTENNA & WAVE PROPAGATION LAB		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam(ESE) UA:OR**	**25 marks**
		Internal Continuous Assessment (ICA) :CA	**25 marks**

Concerned faculty member should suitably frame **SIX** laboratory assignments from the following list.

1. To plot the radiation pattern of a half-wave dipole antenna and determine its beamwidth, directivity, and gain.
2. To experimentally verify the Friis transmission equation and study the relationship between gain, effective aperture, and received power.
3. To study the radiation characteristics of a uniformly spaced two-element linear antenna array with uniform excitation.
4. To study the radiation pattern, polarization, and input impedance of a small circular loop antenna.
5. To measure and plot the E-plane and H-plane radiation patterns of a pyramidal horn antenna and determine gain and beamwidth.
6. To study the broadband characteristics of a log-periodic antenna and observe its frequency-independent behavior.
7. To design, fabricate, and test a rectangular microstrip patch antenna for a specified resonant frequency.
8. To measure return loss, VSWR, bandwidth, and input impedance of a microstrip antenna using a network analyzer.

Guidelines for ICA:

Students must submit ICA in the form of journal. Each assignment should be well documented. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignments.

Guidelines for ESE:

ESE will be based on the laboratory assignments submitted by the students in the form of journal. Evaluation will be based on the understanding and execution.

Kavayitri Bahinabai Chaudhari
NORTH MAHARASHTRA UNIVERSITY,
JALGAON (M.S.)

Bachelor of Engineering – **Honors**
in
VLSI Design & Technology
for Third Year Bachelor of Engineering
in
Electronics &Telecommunication
(As per NEP 2020 Guidelines)

Faculty of Science and Technology

'A' Grade
NAAC Re-Accredited
(4th Cycle)

SYLLABUS STRUCTURE & COURSE OUTLINE
For Affiliated Colleges
Semester – V&VI
W.E.F. 2026 – 27

Syllabus Structure for Honors in VLSI Design and Technology _: Additional Credit (Semester – V) (w.e.f. 2026 – 27)
(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ET -510B	Linear Integrated Circuits	PCC	3			3	40	60			100	3
ET -511B	Linear Integrated Circuits Lab	PCC			2	2			25	25 (OR)	50	1

Syllabus Structure for Honors in: VLSI Design and Technology Additional Credit (Semester – VI) (w.e.f. 2026 – 27)
(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ET -612B	CMOS Integrated Circuits	PCC	3			3	40	60			100	3
ET -613B	CMOS Integrated Circuits Lab	PCC			2	2			25	25 (OR)	50	1

LINEAR INTEGRATED CIRCUITS (PCC) (Honors)					
COURSE OUTLINE					
Course Title:	**LINEAR INTEGRATED CIRCUITS**	**Short Title:**	**LIC**	**Course Code:**	**ET510-B**

Course description:

This course is related to miniaturize electronic circuit that combines numerous electronics components such as transistors, resistor sand capacitors on to single piece of semiconductor material and is known as operational amplifier. The basic operations like inversion, addition, subtraction as well as amplification is analysed in this course. Also, in this course the various applications using op-amp like active filters design, Timer, Analog to digital convertor and digital to analog convertor are included.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03

Prerequisite course(s):

Knowledge of basic electronics components, Analog Electronics theory.

Course objectives:

1.To study the concepts of op-amp configurations
2. To understand fundamental principles of operational amplifier and its parameters.
3. To realize importance of op-amp in linear applications.
4. To analyze different types of Active filters.
5.To study different Analog to Digital and Digital to Analog Convertor

Course outcomes:

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

1**.** Explain basic concept of operational amplifier with its parameters.
2. Apply configuration of op-amp for various application.
3. Identify and describe different applications of op-amp.
4. Design and implement different active filter.
5.Understand operation of Analog to Digital and Digital to Analog Converter

COURSE CONTENT

LINEAR INTEGRATED CIRCUITS		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):UA**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):CA	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction to Operational amplifier :- Block diagram of Op-amp, Op-amp IC 741, Pin diagram, characteristics of Op-amp, Virtual ground concept, Open loop configuration, closed loop configuration, unity gain amplifier, and DC parameter of operational Amplifier.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Op-amp Applications: - Inverting amplifier, non-inverting amplifier, Summing Amplifier, Differential amplifier (subtractor), Integrator, differentiator. Instrumentation amplifier using Op-amp.

Unit–III	No. of Lectures: 09 Hours	Marks:12
Linear Op-amp Applications:-Precision Rectifier, Log Amplifier, Anti-log Amplifier, inverting comparator, Non-inverting Comparator, Schmitt trigger (Regenerative Comparator), Square wave generator (Astable multivibrator using Op-Amp).		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks:12**
Active Filters and IC 555 Timer:-Introduction to active filters, analysis & design of Butterworth filters: Low Pass filter & High Pass filter (First order only). **Introduction of IC 555** (timer IC):-Pin diagram, Features, Block diagram.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks:12**
Analog to digital convertor (ADC) and Digital to Analog convertor (DAC):-Analog to digital convertor, Introduction, classification of ADC, Direct type ADC, Flash type ADC, Ramp type ADC, Successive Approximation type ADC **Digital to Analog convertor:-**Introduction, Specification of DAC like resolution, accuracy and precision, Weighted resistor DAC, R-2R ladder type DAC.		

Text Books:

1. Ramakant A. Gaikwad, “Op Amps and Linear Integrated Circuits” Pearson Education.
2. D. Roy Choudary, Shailendra Jain, “Linear Integrated Circuits” New Age International Pvt. Ltd.

Reference Books:

1. S. Salivahanan, V.S. Kanchana Bhaaskaran, “Linear integrated circuits”, 3rd Edition, McGraw-Hill.
2. William D. StaneIy, “Operational Amplifiers with Linear Integrated Circuits”, 4th Edition, Pearson Education.
3. B. Somanathan Nair, “Linear Integrated Circuits- Analysis, Design & Application” Wiley India.
4. Michael Jacob, “Applications and Design with Analog Integrated Circuits”, 2nd Edition, Prentice Hall of India

NPTEL LINK :

1. Integrated Circuits and Applications by Prof. Shaikh Rafi Ahamed, IIT Guwahati.
https://onlinecourses.nptel.ac.in/noc24_ee73/preview
2. Linear Integrated Circuits, by Dr. Yedukondala Rao Veeranki, NIT Puducherry.
https://onlinecourses.swayam2.ac.in/ntr25_ed139/preview

LINEAR INTEGRATED CIRCUITS LAB (PCC) (Honors)					
LAB COURSE CONTENT					
Course Title:	**LINEAR INTEGRATED CIRCUITS LAB**	**Short Title:**	**LICL**	**Course Code:**	**ET511-B**

Course description:

This course gives the practical knowledge of linear integrated circuit especially operational amplifier. The basic operations like inversion, addition, subtraction as well as amplification are implemented using IC 741. Also, in this course the various applications using op-amp IC 741, active filters design are mentioned.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	2	15	30	1
End Semester Exam(ESE)Pattern:			**Oral (OR)**	

LAB COURSE CONTENT				
LINEAR INTEGRATED CIRCUITS LAB		**Semester:**	**V**	
Teaching Scheme:		**Examination scheme**		
Practical:	**2 hours/week**	**End semester exam(ESE) UA:OR**		**25 marks**
		Internal Continuous Assessment (ICA) :CA		**25 marks**

Concerned faculty member should suitably frame SIX laboratory experiments from the following list.

1. Study of pin details, specifications, applications and features of IC 741(Op-Amp) and IC-555(Timer).
2. Study of Operational Amplifier as a Unity gain amplifier.
3. Study of Operational Amplifier as an Integrator.
4. Study of Operational Amplifier as a Differentiator,
5. Study of Operational Amplifier as a Comparator.
6. Study of Operational Amplifier as Schmitt Trigger
7. Study of Operational Amplifier as first order low pass filter.
8. Study of IC555TIMER as an Astable Multivibrator.

Guide lines for ICA:

Students must submit ICA in the form of journal. Each experiment should be well documented. Faculty in charge will assess the experiment continuously and grade or mark each assignment on completion date declared for each experiment.

Guidelines for ESE:

ESE will be based on the laboratory experiment submitted by the students in the form of journal. Evaluation will be based on the understanding and execution.

CMOS INTEGRATED CIRCUITS (PCC) (Honors)					
COURSE OUTLINE					
Course Title:	**CMOS INTEGRATED CIRCUITS**	**Short Title:**	**CIC**	**Course Code:**	**ET- 612B**
Course description: The scope of the course covers both digital and analog design based standard or custom cells development. Layout fundamentals, both digital & analog analysis (passive components, variations, mismatches etc.).					

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03

Prerequisite course(s):

1. Basic Electronics
2. Semiconductor Devices
3. Introduction to Analog Electronics
4. Introduction to Digital Electronics

Course objectives:

1. To understand different CMOS logic families and their circuit layout.
2. To understand various VLSI design methodologies.
3. To learn how to model, analyze digital integrated circuits.
4. To learn how to simulate digital integrated circuits.
5. To design digital integrated circuits.

Course outcomes:

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

1. Describe the CMOS Logic families & their circuit layout.
2. Describe various VLSI design methodologies.
3. Analyze the analog & digital CMOS circuits for specified applications.
4. Simulate digital integrated circuits.
5. Acquire knowledge to Design of Data Processing Elements using VHDL.

COURSE CONTENT

		Semester:	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE) :UA**	**60 marks**
		Duration of ESE :	**03 hours**
		Internal Sessional Exams (ISE):CA	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction to CMOS Technology:-MOS Transistors, MOS Transistors Switches, CMOS Logic: The Inverter, Combinational Logic, The NAND Gate, NOR Gate, Compound Gates, Multiplexers, Memory-Latches and Registers.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

CMOS Processing Technology:-Silicon Semiconductor Technology: An overview: Wafer Processing, Oxidation, Epitaxy, Deposition, Ion-Implantation, and Diffusion,The silicon Gate Process. Basic CMOS Technology: A basic n-well CMOS Process, The p-well process, Twin – Tub Process, Circuit Elements: Resistors, Capacitors.

Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**

Combinational Circuit Design:-Comparison of Circuit families: Static CMOS, Rationed

Circuits, and Cascade Voltage Switch Logic. Dynamic Circuits and Dual- Rail Domino Multiple Output Domino Logic. BiCMOS Circuits: BiCMOS NAND Gate.

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**

Sequential Circuit Design: - Sequencing Static Circuits. Design of latches and flip flops. Conventional CMOS Latches Pulsed Latches. Conventional CMOS Flip-Flops, Resettable Latches and Flip Flops, Enabled Latches and Flip Flops.

Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**

VHDL:-Behavioral Modeling With Concurrent Signal Assignments. Bitwise Operators. Comments and white space. Other Operator. Conditional Signal Assignment Statements. Selected Signal Assignment Statements. Basic Constructs: Blocks, Entities and Architecture. Hierarchy, Types. Library and Use Clauses. Tri-states.

Text Books:

1. N.H.E. Weste and D.M. Harris, "CMOS VLSI design: A Circuits and Systems Perspective" 4th Edition, Pearson Education India, 2011.
2. N.H.E. Weste and Kamran Eshraghian , "Principles of CMOS VLSI Design, A Systems Perspective," 4th Edition, Pearson Education India, 2011.

Reference Books:

1. P. Allen and D. Holberg "CMOS Analog Circuit Design", Oxford University Press.
2. B. Razavi "Design of Analog CMOS Integrated Circuits", Tata McGraw-Hill.
3. P. Gray, P. Hurst, S. Lewis and R. Meyer "Analysis and Design of Analog Integrated Circuits", Wiley Sons.

NPTEL LINK:

1. VLSI Circuits by Prof. Srinivasan, IIT Madras .
   https://nptel.ac.in/courses/117106092
2. Digital Systems Design by Prof. D. Roychoudhury IIT Kharagpur
   https://nptel.ac.in/courses/117105080

CMOS INTEGRATED CIRCUITS LAB(PCC) (Honors)					
LAB COURSE OUTLINE					
Course Title:	**CMOS INTEGRATED CIRCUITS LAB**	**Short Title:**	**CDL**	**Course Code:**	**EC-613B**

Course description: This course introduces the fundamental concepts of CMOS technology through the study of MOS transistor characteristics and CMOS fabrication processes. It focuses on the design and simulation of basic and advanced CMOS circuits such as inverters, logic gates, multiplexers, latches, and flip-flops. The course also provides hands-on experience in modeling and simulating CMOS circuits using VHDL for practical digital system design.

Laboratory	Hours/week	No. of weeks	Total hours	Semester credits
	02	15	30	01

End Semester Exam(ESE)Pattern:	Oral (OR)

LAB COURSE CONTENT

CMOS INTEGRATED CIRCUITS LAB		Semester:	VI
Teaching Scheme:		Examination scheme	
		End Semester Exam(ESE):UA (OR)	25 Marks
Practical	4 hours/week	Internal Continuous Assessment (ICA):CA	25 Marks

Concerned faculty member should suitably frame SIX laboratory assignments from the Following list.

1. Study of MOS Transistor Characteristics.
2. Design and Simulation of CMOS Inverter.
3. Design of CMOS NAND and NOR Gates.
4. Design of Multiplexer Using CMOS Logic.
5. Study of CMOS Fabrication Process.
6. Design of CMOS Latches.
7. Design of CMOS Flip-Flops.
8. VHDL Modeling of CMOS Circuits.

Guidelines for ICA:

Students must submit ICA in the form of journal .Each assignment should be well documented. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignments.

Guidelines for ESE:

ESE will be based on the laboratory assignments submitted by the students in the form of journal. Evaluation will be based on the understanding and execution.

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Bachelor of Engineering – Honors
in
Data Science in Telecom
for Third Year Bachelor of Engineering
in
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Faculty of Science and Technology

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SYLLABUS STRUCTURE & COURSE OUTLINE
For Affiliated Colleges
Semester – V & VI
W.E.F. 2026– 27

Syllabus Structure for Honors in Data Science in Telecom: Additional Credit (Semester – V) (w.e.f. 2026 – 27)
(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ET -510C	Telecom Signal Analytics	PCC	3			3	40	60			100	3
ET -511C	Telecom Signal Analytics Lab	PCC			2	2			25	25 (OR)	50	1

Syllabus Structure for Honors in Data Science in Telecom: Additional Credit (Semester – VI) (w.e.f. 2026 – 27)
(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ET -612C	Data Science and Its Application	PCC	3			3	40	60			100	3
ET -613C	Data Science and Its Application Lab	PCC			2	2			25	25 (OR)	50	1

TELECOM SIGNAL ANALYTICS (PCC) (Honors)					
COURSEOUTLINE					
Course Title:	**TELECOM SIGNAL ANALYTICS**	**Short Title:**	**TSA**	**Course Code:**	**ET-510C**

Course description:

This course introduces the analysis and processing of communication signals in modern telecommunication systems. It covers statistical and transform-domain signal analytics techniques used for signal characterization, detection, and performance evaluation. The course equips students with tools for both theoretical analysis and practical signal analytics in telecom applications.

Lecture	Hours/week	No. of weeks	Total hours	Semester credits
	3	15	45	3

Prerequisite course(s):

Signals & Systems fundamentals , Basics of Digital Communications and Probability theory

Course objectives:

1. Understand fundamental signal representations used in telecom engineering.
2. Analyze statistical properties of communication signals.
3. Evaluate performance metrics like BER and signal detection probability.
4. Apply transform-domain techniques for telecom signal insight.
5. Explore advanced signal analytics applications in modern wireless systems.

Course outcomes:

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

1. Classify and represent signals in time, frequency, and statistical domains.
2. Analyze the impact of noise and channel effects on telecom signals.
3. Compute key metrics such as PSD and correlation functions for real signals.
4. Use analytical tools (Fourier, STFT) for signal processing tasks.
5. Apply signal analytics concepts to real-world telecom systems such as 4G/5G networks.

COURSE CONTENT

TELECOM SIGNAL ANALYTICS		Semester:	V
Teaching Scheme:		**Examination Scheme:**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE):UA**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam(ISE):CA	**40 marks**

Unit–I:	No. of Lectures: 09 Hours	Marks: 12

Introduction to Telecom Signal Analytics: - Types of communication signals (continuous & discrete) , Signal representation in time and frequency domains, Review of Fourier Transform and spectral analysis.

Unit–II:	No. of Lectures: 09 Hours	Marks: 12

Statistical Signal Analysis:- Random processes & statistical measures, Autocorrelation, cross-correlation, Power spectral density (PSD) and Wiener–Khintchine theorem.

nit–III:	No. of Lectures: 09 Hours	Marks: 12

Digital Modulation & Detection Analytics : Signal constellation and metrics, Error performance (BER, SER) analysis,Detection theory basics (matched filter, correlator)

Unit–IV:	No. of Lectures: 09 Hours	Marks: 12

Noise & Channel Impact on Signals: - Noise models and effects on signals, Signal distortion analysis, Introduction to fading channel statistics.

Unit–V:	No. of Lectures: 09 Hours	Marks: 12

Analytical Tools & Applications in Telecom:- Time-frequency analysis (STFT, wavelets), Machine learning basics for signal classification, Case studies: 4G/5G signal analytics, spectrum sensing.

Text Books:

1. B. P. Lathi & Z. Ding — "Modern Digital and Analog Communication Systems", Oxford Press
2. John G. Proakis & M. Salehi — "Digital Communications", McGraw-Hill Publications.

Reference Books:

1. Simon Haykin — "Communication Systems"Wiley Sons.
2. Leon W. Couch — "Digital and Analog Communication Systems" Pearson Education.

NPTEL Link –

1. Covers foundational signal analysis tools essential for this subject. https://onlinecourses.nptel.ac.in/noc26_ee37/preview
2. Principles of Communication Systems – I (NPTEL course) – Builds on modulation, detection, and signal properties. https://onlinecourses.nptel.ac.in/noc26_ee36/preview
3. Applied Linear Algebra for Signal 3.Processing, Data Analytics and Machine Learning Useful for advanced analytics tools https://onlinecourses.nptel.ac.in/noc25_ee113/preview

TELECOM SIGNAL ANALYTICS LAB (PCC) (Honors)					
LAB COURSE OUTLINE					
Course Title:	**TELECOM SIGNAL ANALYTICS LAB.**	**Short Title:**	**TSAL**	**Course Code:**	**EC- 511C**

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	02	15	30	1

End Semester Exam(ESE)Pattern:	**Oral (OR)**

LAB COURSE CONTENT			
TELECOM SIGNAL ANALYTICS LAB		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Practical:	**2hours/week**	**End semester exam(ESE) :UA(OR)**	**25 marks**
		Internal Continuous Assessment (ICA):CA	**25 marks**

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. Time and Frequency Domain Analysis of Communication Signals.
2. Computation of Autocorrelation and Cross-Correlation.
3. Power Spectral Density (PSD) Estimation
4. Simulation of Digital Modulation Schemes.
5. BER Performance Analysis in AWGN Channel
6. Matched Filter and Signal Detection
7. Time-Frequency Analysis using STFT
8. Spectrum Sensing / Signal Classification using Basic ML.

Guidelines for ICA:

Students must submit ICA in the form of journal. Each assignment should be well documented. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignments.

Guidelines for ESE:

ESE will be based on the laboratory assignments submitted by the students in the form of journal. Evaluation will be based on the understanding and execution.

DATA SCIENCE AND ITS APPLICATION (PCC) (Honors)					
COURSE OUTLINE					
Course Title:	**DATA SCIENCE AND ITS APPLICATION**	**Short Title:**	**DSA**	**Course Code:**	**ET-612C**

Course description:

This course introduces the fundamental concepts, workflow, and real-world applications of Data Science, covering data collection, preprocessing, analysis, and interpretation. Students will learn statistical methods, basic machine learning techniques, and modern tools such as Python libraries for data handling and visualization. Emphasis is placed on transforming raw data into meaningful insights and effectively communicating results for informed decision-making across diverse application domains.

Lecture	Hours/week	No. of weeks	Total hours	Semester credits
	3	15	45	3

Prerequisite course(s):

Basic programming knowledge (preferably Python), foundational mathematics and statistics

Course objectives:

1. To understand the basics of data science and data science workflow.
2. To apply techniques for cleaning and transforming data and visualize data to identify patterns and trends.
3. To apply basic statistical methods to analyze data
4. To explain the basic concepts of machine learning.
5. To Utilize appropriate visualization techniques to communicate complex data patterns and relationships effectively.

Course outcomes:

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

1. Explain basics of data science and data science workflow
2. Apply techniques for cleaning and transforming data and visualize data to identify patterns and trends.
3. Apply basic statistical methods to analyze data
4. Explain the basic concepts of machine learning
5. Utilize appropriate visualization techniques to communicate complex data patterns and relationships effectively.

COURSE CONTENT

		Semester:	**VI**
Teaching Scheme:		**Examination Scheme:**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE):UA**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam(ISE):CA	**40 marks**

Unit–I:	No. of Lectures: 09 Hours	Marks: 12

Introduction to Data Science and Data Science Workflow:- What is Data Science, Types of Data: Structured, Unstructured, Semi-structured, Overview of Data Science Workflow: Data Collection, Cleaning, Exploration, Modeling, Evaluation, Introduction to Python and R for Data Science, Tools for Data Science: Jupyter Notebooks, Pandas, Matplotlib, Scikit-learn

Unit–II:	No. of Lectures: 09 Hours	Marks: 12

Data Exploration and Preprocessing Data Cleaning:- Handling Missing Data, Outliers, and Duplicates, Data Transformation: Normalization, Scaling, Encoding Categorical Data, Data Wrangling with Pandas, Data Visualization: Using Matplotlib and Seaborn, Descriptive Statistics

(Mean, Median, Mode, Variance, Standard Deviation).

Unit–III:	No. of Lectures: 09 Hours	Marks: 12

Statistical Methods in Data Science Probability Theory Basics, Inferential Statistics: - Hypothesis Testing, p-values, Confidence Intervals, Correlation and Causality, Linear Regression and its Statistical Foundations.

Unit–IV:	No. of Lectures: 09 Hours	Marks: 12

Introduction to Machine Learning Overview of Machine Learning: Supervised vs Unsupervised Learning, Classification Algorithms: Logistic Regression, Decision Trees, Regression Algorithms: Linear Regression, Ridge, Lasso, Model Evaluation: Confusion Matrix, Accuracy, Precision, Recall, F1-score.

Unit–V:	No. of Lectures: 09Hours	Marks: 12

Data Visualization and Communication Principles of Effective Data Visualization, Creating Interactive Visualizations with Plotly and Dash, Communicating Data Science Findings: Storytelling with Data Visualizing Multivariate Data.

Text Books:

1. Wes McKinney “Python for Data Analysis”.
2. Foster Provost and Tom Fawcett "Data Science for Business".

Reference Books:

1. Peter Bruce, Andrew Bruce, Peter Gedeck “Practical Statistics for Data Scientists"
2. Aurélien Géron "Hands-On Machine Learning with Scikit-Learn, Keras, and Tensor Flow"

NPTEL LINK:-

1. Data Science for Engineers, IIT Madras by Prof. Ragunathan Rengasamy, Prof. Shankar Narasimhan, https://nptel.ac.in/courses/106106179
2. Introduction to Machine Learning by Prof. Sudeshna Sarkar IIT Kharagpur https://nptel.ac.in/courses/106105152

DATA SCIENCE AND ITS APPLICATION LAB (PCC) (Honors)					
LAB COURSE OUTLINE					
Course Title:	**DATA SCIENCE AND ITS APPLICATION LAB**	**Short Title:**	**DSAL**	**Course Code:**	**ET- 613C**

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	02	15	30	1

End Semester Exam(ESE)Pattern:	**Oral (OR)**

LAB COURSE CONTENT			
DATA SCIENCE AND ITS APPLICATION		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Practical:	**2hours/week**	**End semester exam(ESE): UA(OR)**	**25 marks**
		Internal Continuous Assessment (ICA):CA	**25 marks**

Concerned faculty member should suitably frame SIX laboratory assignments from the list

1. Study of Data Science Workflow using Python.
2. Data Cleaning and Preprocessing using Pandas.
3. Descriptive Statistics and Data Visualization.
4. Data Wrangling and Transformation.
5. Statistical Analysis and Hypothesis Testing.
6. Linear Regression and Correlation Analysis.
7. Classification and Regression using Machine Learning Algorithms.
8. Model Evaluation and Interactive Data Visualization.

Guidelines for ICA:

Students must submit ICA in the form of journal. Each assignment should be well documented. faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignments.

Guidelines for ESE:

ESE will be based on the laboratory assignments submitted by the students in the form of journal. Evaluation will be based on the understanding and execution.

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Bachelor of Engineering – **Minor**

in

5G & Advanced Technology

for Third Year Bachelor of Engineering

(As per NEP 2020 Guidelines)

Faculty of Science and Technology



SYLLABUS STRUCTURE & COURSE OUTLINE
For Affiliated Colleges
Semester – V& VI
W.E.F. 2026-27

Syllabus Structure for Specialization Minor in 5G and Advance Technology: Additional Credit (Semester – V) (w.e.f. 2026 – 27)

(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ET -512A	Microwave Theory and Techniques	PCC	3			3	40	60			100	3
ET -513A	Microwave Theory and Techniques Lab	PCC			2	2			25	25 (OR)	50	1

Syllabus Structure for Specialization Minor in 5G and Advance Technology: Additional Credit (Semester – VI) (w.e.f. 2026 – 27)

(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ET -614A	Antenna Theory	PCC	3			3	40	60			100	3
ET -615A	Antenna Theory Lab	PCC			2	2			25	25 (OR)	50	1

MICROWAVE THEORY AND TECHNIQUE (PCC) (Specialization Minor)					
COURSE OUTLINE					
Course Title:	**MICROWAVE THEORY AND TECHNIQUE**	**Short Title:**	**MTT**	**Course Code:**	**ET-512 A**

Course description:

This course is designed to lay the foundation of microwave theory. The various modes of propagations through wave guides are included. Students will become familiar with the usage of active and passive components of microwave systems. Measurements of various parameters of microwave systems and Modern trends of microwave engineering.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03

Prerequisite course(s):

Electromagnetic theory, Wave propagation, Antennas and Semiconductor physics.

Course objectives:

1. To study the basics concept of various mode of propagation in waveguide.
2. To understand the fundamentals of microwave passive components.
3. To familiarize the concept of microwave active devices.
4. Provide strong foundation for understanding of microwave measurement and microwave antenna.
5. To Learn the modern trends in microwave Engineering.

Course outcomes:

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

1. Describe the basic concepts and applications of microwave systems.
2. Analyze, test and use various passive microwave components for different applications.
3. Describe the concept of microwave active tubes.
4. Apply the concept for measurement of various parameters of microwave system.
5. To describe the modern trends in microwave engineering.

Microwave Theory and Technique

COURSE CONTENT

MICROWAVE THEORY AND TECHNIQUE		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):UA**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):CA	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction to Microwaves:-History of Microwaves, Microwave Frequency bands; General Application of Microwave, Advantages-Rectangular, Circular, & Disadvantages. Types of waveguide, Mathematical Model of Microwave Transmission-Concept of Mode, Features of TEM, TE and TM Modes, Mathematical derivation of TEM Mode, TM Mode, TE Mode, Cut off frequency ,Phase velocity, Group Velocity ,Guide wavelength, wave Impedance for rectangular waveguide.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Passive Microwave Devices- Microwave passive components: E Plane Tee, H- Plane Tee Magic

Tee, Directional Coupler, Analysis with S Matrix ,Attenuator, Frequency meter, Ferrite Devices- Isolator, circulator, Microwave filters, Matched Terminations, waveguide Bends, Twist.		
Unit–III:	**No. of Lectures: 09 Hours**	**Marks:12**
Active Microwave Devices: - Microwave tubes: Klystron, TWT, Backward Wave Oscillator, Magnetron. Gunn Diodes, Tunnel diode, PIN diodes, Varactor diodes, IMPATT and TRAPATT diodes, Parametric Amplifiers.		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks:12**
Microwave Measurements: - Frequency-Electronics Method, Mechanical Method, Power, VSWR, attenuation, Impedance measurement. **Microwave Antennas:** Fundamental parameters of antennas**,** Horn antenna, Parabolic reflector with all types of feeding methods, slotted antenna, Lens antenna,		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks:12**
Modern Trends in Microwaves Engineering:-Effect of Microwaves on human body, Medical and Civil applications of microwaves, Electromagnetic interference / Electromagnetic Compatibility (EMI / EMC), Monolithic Microwave IC fabrication , RF MEMS for microwave components, **Microwave Systems:-**Wireless Communications system, Radar Systems, Radiometer Systems.		
Text Books:		
1. Samuel Liao, "Microwave Devices and Circuits", Pearson Education, 3/e. 2. Annapurna Das, Sisir Das, "Microwave Engineering", TMH, 3/e		
Reference Books:		
1. Robert E Collin, "Foundations for Microwave Engineering," Wiley India, 2/e. 2. Sisodia, Gupta, "Microwaves: Introduction to Circuits, Devices and Antennas", New Age, 1/e.		
NPTEL LINK : 1. Directivity and Gain by Prof Amitabha Bhattacharya, IIT Kharagpur https://www.youtube.com/watch?v=66cOzMYWmWc&list=PLbRMhDVUMngfytbQXzasPMHuWst4E-Ly8&index=7 2. Analysis and Design Principles of Microwave Antennas by Prof Amitabha Bhattacharya, IIT Kharagpur https://youtu.be/h51mFbIgZRI?si=vIJWH9WRH3POyrZs 3. Microwave Theory and Techniques by Prof. Girish Kumar, IIT Bombay https://onlinecourses.nptel.ac.in/noc20_ee63/preview?utm_source		

MICROWAVE THEORY AND TECHNIQUE LAB (PCC)					
LAB COURSE CONTENT					
Course Title:	**MICROWAVE THEORY AND TECHNIQUE LAB**	**Short Title:**	**MTTL**	**Course Code:**	**ET-513A**

Course description:

This course is designed to provide hands-on experimental exposure to microwave engineering concepts essential for understanding high-frequency communication systems. The course introduces students to microwave frequency bands, waveguide structures, and propagation mechanisms, enabling them to analyze electromagnetic wave behavior in rectangular and circular waveguides. Experiments focus on the measurement of key waveguide parameters such as cutoff frequency, phase and group velocity, guide wavelength, and wave impedance for various modes of propagation (TE, TM, and TEM).

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	2	15	30	1

End Semester Exam(ESE) Pattern		**Oral (OR)**	
LAB COURSE CONTENT			
MICROWAVE THEORY AND TECHNIQUE LAB		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam(ESE) :UA(OR)**	**25 marks**
		Internal Continuous Assessment (ICA) :CA	**25 marks**

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. Plot and study V-I Characteristics of GUNN Diode
2. Plot and study Reflex Klystron Characteristics.
3. Measurement of Attenuation (Fixed and Variable).
4. Measurement of isolation and coupling factor of magic tee.
5. Measurement of coupling factor and directivity of Directional coupler.
6. Measurement of insertion loss and isolation of circulator and isolator.
7. Measurement of VSWR (using Vmax / Vmin method).
8. Measurement of polar pattern and the gain of waveguide horn antenna.

Guidelines for ICA:

Students must submit ICA in the form of a journal. Each experiment should be well documented. The faculty in charge will assess the experiments continuously and grade or mark each experiment on the completion date declared for each experiment.

Guidelines for ESE:

ESE will be based on the laboratory experiments submitted by the students in the form of a journal. Evaluation will be based on understanding and execution.

ANTENNA THEORY (PCC) (Specialization Minor)					
COURSE OUTLINE					
Course Title:	**ANTENNA THEORY**	**Short Title:**	**AT**	**Course Code:**	**ET-614 A**

Course description:

This course introduces antenna fundamentals, focusing on radiation mechanisms, antenna parameters, and performance metrics such as radiation pattern, directivity, gain, bandwidth, polarization, efficiency, and impedance. Mathematical tools including radiation integrals and vector potentials are developed to analyze antenna radiation in the far field. This course also equips students with both theoretical foundations and practical insights necessary for the analysis, design, and application of antennas in wireless communication, radar, broadcasting, satellite, and microwave systems.

	Hours/week	No. of weeks	Total hours	Semester credits
Theory	03	15	45	03

Prerequisite course(s):

Knowledge of basic Electrical and Electronics Engineering and its concept.

Course objectives:

1. To understand the applications of electromagnetic engineering.
2. To analyse and understand the Uniform plane wave propagation in various media.
3. To solve the electric field and magnetic fields for a given wire antenna.
4. To formulate and solve the Helmholtz wave equation and solve it for Uniform Plane Wave.
5. To analyse the given antenna array and its radiation characteristics

Course outcomes:

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

1. Students will describe the mathematical concepts of antenna theory and its analysis.
2. Formulate the wave equation and solve it for uniform plane wave.
3. Analyse the given wire antenna and its radiation characteristics.
4. Identify the suitable antenna for a given communication system.
5. Analyse the given antenna array and its radiation characteristics.

ANTENNA THEORY

COURSE CONTENT

ANTENNA THEORY		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):UA**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):CA	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

.**Uniform Plane Waves:-** Maxwell Equations in phasor form, Wave Equation, Uniform Plane wave in Homogeneous, free space, dielectric, conducting medium. Polarization: Linear, circular

& Elliptical polarization, unpolarised wave. Reflection of plane waves, Normal incidence, oblique incidence, Electromagnetic Power and Poynting theorem and vector.

Unit–II:	No. of Lectures: 09 Hours	Marks: 12

Antenna Fundamentals:-Introduction, Types of Antenna, Radiation Mechanism, AntennaTerminology: Radiation pattern, radiation power density, radiation intensity, directivity, gain, antenna efficiency, half power beam width, bandwidth, antenna polarization, input impedance, antenna radiation stable and unstable **efficiency,** effective length, effective area, reciprocity. Radiation Integrals: Vector potentials A, J, F, M, Electric and magnetic fields electric and magnetic current sources, solution of inhomogeneous vector potential wave equation, far field radiation.

Unit–III:	No. of Lectures: 09 Hours	Marks:12

Wire Antennas: - Analysis of Linear and Loop antennas: Infinitesimal dipole, small dipole, and finite length dipole half wave length dipole, small circular loop antenna. Complete Analytical treatment of all these elements.

Unit–IV:	No. of Lectures: 09 Hours	Marks:12

Antenna Arrays:- Two element array, pattern multiplication N-element linear array, uniform amplitude and spacing, broad side and end-fire array, N-element array: Uniform spacing, non-uniform amplitude, array factor, binomial and Dolph T chebyshev array. Planar Array, Circular Array, Log Periodic Antenna, Yagi Uda Antenna Array.

Unit–V:	No. of Lectures: 09 Hours	Marks:12

Antennas and Applications:- Structural details, dimensions, radiation pattern, specifications, features and applications of following Antennas: Hertz & Marconi antennas, V- Antenna, Rhombic antenna. TW antennas. Loop antenna, Whip antenna, Biconical, Helical, Horn, Slot, Microstrip, Turnstile, Super turnstile & Lens antennas. Antennas with parabolic reflectors.

Text Books:

1. C. A. Balanis, "Antenna Theory and Design", 3rd Ed., John Wiley &Sons. 2005.
2. K.D.Prasad " Antennas And Wave Propagation".Satya Publication.

Reference Books:

1. Harish A. R.,Antenna and wave propagation, Oxford University Press. Tri T. Ha, "Digital Satellite Communications", Tata McGraw-Hill,2009.
2. J.D.Kraus, "Antennas",McGraw-Hill,1988.

NPTEL LINK:-

1. Fundamentals of Antennas, by Prof. Girishkumar, IIT Bombay.
https://www.youtube.com/watch?v=1J_iDY1CEk0&t=15
2. Electromagnetic Fields & Waves by Prof. Prof. R. K. Shevgaonkar, IIT Bombay.
https://www.youtube.com/playlist?list=PLbMVogVj5nJTY9cV2w1z8O0jL9JZ8b5M0

ANTENNA THEORY LAB (PCC) (Specialization Minor)					
LAB COURSE CONTENT					
Course Title:	**ANTENNA THEORY LAB**	**Short Title:**	**ATL**	**Course Code:**	**ET-615 A**

Course description:

This laboratory course develops experimental skills, analytical thinking, and practical understanding of electromagnetic waves and antenna systems, preparing students for advanced studies and professional practice in RF, microwave, and wireless communication engineering. Practical analysis of wire antennas, including half-wave dipole and small loop antennas, allows students to study radiation mechanisms, input impedance, polarization, and radiation resistance. The laboratory further explores antenna array behavior, emphasizing pattern multiplication.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	2	15	30	1

End Semester Exam (ESE) Pattern	**Oral (OR)**

LAB COURSE CONTENT			
ANTENNA THEORY LAB		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam(ESE): UA(OR)**	**25 marks**
		Internal Continuous Assessment (ICA) :CA	**25 marks**

Concerned faculty member should suitably frame SIX laboratory experiments from the following list.

1. To study uniform plane wave propagation in free space, dielectric, and conducting media using Maxwell's equations in phasor form and to verify wave parameters.
2. To analyze linear, circular, and elliptical polarization of plane waves and verify electromagnetic power flow using the Poynting vector.
3. To plot the radiation pattern of a given antenna and determine half-power beamwidth, directivity, and gain.
4. To experimentally verify antenna reciprocity and determine effective length and effective area using transmission–reception principles.
5. To study radiation pattern, input impedance, and radiation resistance of a half-wave dipole antenna.
6. To analyze the radiation pattern, polarization, and impedance characteristics of a small circular loop antenna.
7. To study pattern multiplication and radiation characteristics of a two-element linear antenna array for broadside and end-fire configurations.
8. To study gain, bandwidth, and directivity characteristics of Yagi–Uda or log-periodic antenna arrays.

Guidelines for ICA:

Students must submit ICA in the form of a journal. Each experiment should be well documented. The faculty in charge will assess the experiments continuously and grade or mark each experiment on the completion date declared for each experiment.

Guidelines for ESE:

ESE will be based on the laboratory experiments submitted by the students in the form of a journal. Evaluation will be based on understanding and execution.

Kavayitri Bahinabai Chaudhari
NORTH MAHARASHTRA UNIVERSITY,
JALGAON (M.S.)

Bachelor of Engineering – **Minor**

in

VLSI Design & Technology

for Third Year Bachelor of Engineering

(As per NEP 2020 Guidelines)

Faculty of Science and Technology



SYLLABUS STRUCTURE & COURSE OUTLINE
For Affiliated Colleges
Semester – V& VI
W.E.F. 2026– 27

Syllabus Structure for Specialization Minor in VLSI Design and Technology: Additional Credit (Semester – V) (w.e.f. 2026 – 27)

(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ET -512B	Analog Integrated Circuit & Application	PCC	3			3	40	60			100	3
ET -513B	Analog Integrated Circuit & Application Lab	PCC			2	2			25	25 (OR)	50	1

Syllabus Structure for Specialization Minor in VLSI Design and Technology: Additional Credit (Semester – VI) (w.e.f. 2026 – 27)

(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ET -614B	CMOS Design	PCC	3			3	40	60			100	3
ET -615B	CMOS Design Lab	PCC			2	2			25	25 (OR)	50	1

ANALOG INTEGRATED CIRCUITS AND APPLICATIONS (PCC) (Specialization Minor)					
COURSE OUTLINE					
Course Title:	**Analog Integrated Circuits And Applications**	**Short Title:**	**AICA**	**Course Code:**	**ET512-B**

Course description:

This course is related to miniaturize electronic circuit that combines numerous electronics components such as transistors, resistor sand capacitors on to single piece of semiconductor material and is known as operational amplifier. The basic operations like inversion, addition, subtraction as well as amplification is analysed in this course. Also, in this course the various applications using op-amp like active filters design, Timer, Analog to digital convertor and digital to analog convertor are included.

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03

Prerequisite course(s):

Knowledge of basic electronics components, Analog Electronics theory.

Course objectives:

1. To study the concepts of op-amp configurations
2. To understand fundamental principles of operational amplifier and its parameters.
3. To realize importance of op-amp in linear applications.
4. To analyze different types of Active filters.
5. To study different Analog to Digital and Digital to Analog Convertor.

Course outcomes:

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

1. Explain basic concept of operational amplifier with its parameters.
2. Apply configuration of op-amp for various application.
3. Identify and describe different applications of op-amp.
4. Design and implement different active filter.
5. Understand operation of Analog to Digital and Digital to Analog Convertor.

COURSE CONTENT

Analog Integrated Circuits And Applications		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):UA**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):CA	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction to Operational amplifier :-Block diagram of op-amp, Op-amp IC 741, pin diagram, characteristics of Op-amp, Virtual ground concept, Open loop configuration, closed loop configuration, unity gain amplifier, DC parameter of operational Amplifier.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Op-amp Applications:- Inverting amplifier, non-inverting amplifier, Summing Amplifier, Differential amplifier (subtractor), Integrator, differentiator. Instrumentation amplifier using Op-amp.

Unit–III	No. of Lectures: 09 Hours	Marks:12
Linear Op-amp Applications:-Precision Rectifier, Log Amplifier, Anti-log Amplifier, inverting comparator, Non-inverting Comparator, Schmitt trigger (Regenerative Comparator), Square wave generator (A stable multivibrator using Op-Amp).		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks:12**
Active Filters and IC 555 Timer Introduction to active filters, analysis & design of Butterworth filters: Low Pass filter &High Pass filter (First order only). Introduction of IC 555 (timer IC), Pin diagram, Features, Block diagram.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks:12**
Analog to digital convertor (ADC) and Digital to Analog convertor (DAC) Analog to digital convertor, Introduction, classification of ADC, Direct type ADC, Flash type ADC, Ramp type ADC, Successive Approximation type ADC. **Digital to Analog convertor** Introduction, Specification of DAC like resolution, accuracy and precision, Weighted resistor DAC, R-2R ladder type DAC.		
Text Books:		
1. Ramakant A. Gaikwad, “Op Amps and Linear Integrated Circuits” Pearson Education 2. D.Roy Choudary, Shail Jain, “Linear Integrated Circuits”, New Age International Pvt. Ltd.		
Reference Books:		
1. S. Salivahanan, V.S. Kanchana Bhaaskaran, “Linear integrated circuits”, 3rd Edition, McGraw-Hill. 2. William D.StaneIy, “Operational Amplifiers with Linear Integrated Circuits”, 4th Edition, Pearson Education. 3. B. Somanathan Nair, “Linear Integrated Circuits- Analysis, Design &Application”,Wiley India. 4. Michael Jacob, "Applications and Design with Analog Integrated Circuits”, 2nd Edition, Prentice Hall of India		
NPTEL LINK : 1. Integrated Circuits and Applications by Prof. Shaikh Rafi Ahamed, IIT Guwahati. https://onlinecourses.nptel.ac.in/noc24_ee73/preview 2. Linear Integrated Circuits, by Dr. Yedukondala Rao Veeranki, NIT Puducherry. https://onlinecourses.swayam2.ac.in/ntr25_ed139/preview		

ANALOG INTEGRATED CIRCUITS AND APPLICATIONS LAB (PCC) (Specialization Minor)					
LABCOURSECONTENT					
Course Title:	**Analog Integrated Circuits And Applications Lab**	**Short Title:**	**AICL**	**Course Code:**	**ET513-B**

Course description:

This course gives the practical knowledge of linear integrated circuit especially operational amplifier. The basic operations like inversion, addition, subtraction as well as amplification are implemented using IC 741. Also, in this course the various applications using op-amp IC 741, active filters design are mentioned.

Laboratory	Hours/week	No. of weeks	Total hours	Semester credits
	2	15	30	1

End Semester Exam(ESE)Pattern:		**Oral (OR)**	
LAB COURSE CONTENT			
		Semester:	**V**
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam(ESE) :UA(OR)**	**25 marks**
		Internal Continuous Assessment (ICA) :CA	**25 marks**

Concerned faculty member should suitably frame SIX laboratory experiment from the Following list.

1. Study of pin details, specifications, applications and features of IC741 (Op-Amp) and IC555(Timer).
2. Study of Operational Amplifier as a Unity gain amplifier.
3. Study of Operational Amplifier as an Integrator.
4. Study of Operational Amplifier as a Differentiator,
5. Study of Operational Amplifier as a Comparator.
6. Study of Operational Amplifier as Schmitt Trigger
7. Study of Operational Amplifier as first order low pass filter.
8. Study of IC555TIMER as an Astable Multivibrator.

Guidelines for ICA:

Students must submit ICA in the form of a journal. Each experiment should be well documented. The faculty in charge will assess the experiments continuously and grade or mark each experiment on the completion date declared for each experiment.

Guidelines for ESE:

ESE will be based on the laboratory experiments submitted by the students in the form of a journal. Evaluation will be based on understanding and execution.

CMOS DESIGN (PCC) (Specialization Minor)					
COURSE OUTLINE					
Course Title:	**CMOS DESIGN**	**Short Title:**	**CMOS D**	**Course Code:**	**ET- 614B**
Course description: The scope of the course covers both digital and analog design based standard or custom cells development. Layout fundamentals, both digital &analog analysis (passive components, variations, mismatches etc.).					

	Hours/week	**No. of weeks**	**Total hours**	**Semester credits**
Theory	03	15	45	03

Prerequisite course(s):

1.Basic Electronics ,
2. Semiconductor Devices
3. Introduction to Analog Electronics
4. Introduction to Digital Electronics

Course objectives:

objectives:
1. To understand different CMOS logic families and their circuit layout.
2. To understand various VLSI design methodologies.
3. To learn how to model, analyze digital integrated circuits.
4. To learn how to simulate digital integrated circuits.
5. To design digital integrated circuits.

Course outcomes:

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

1. Describe the CMOS Logic families & their circuit layout.
2. Describe various VLSI design methodologies.
3. Analyze the analog & digital CMOS circuits for specified applications.
4. Simulate digital integrated circuits.
5. Acquire knowledge to Design of Data Processing Elements using VHDL.

COURSE CONTENT

		Semester:	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE): UA**	**60 marks**
		Duration of ESE :	**03 hours**
		Internal Sessional Exams (ISE):CA	**40 marks**
Unit–I:		**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction to CMOS Technology:-MOS Transistors, MOS Transistors Switches. CMOS Logic: The Inverter, Combinational Logic, The NAND Gate, NOR Gate, Compound Gates, Multiplexers, Memory-Latches and Registers.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

CMOS Processing Technology:-Silicon Semiconductor Technology: An overview: Wafer Processing, Oxidation, Epitaxy, Deposition, Ion-Implantation, and Diffusion. The silicon Gate Process. Basic CMOS Technology: A basic n-well CMOS Process, The p-well process, Twin – Tub Process, Circuit Elements: Resistors, Capacitors.

Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**

Combinational Circuit Design:-Comparison of Circuit families: Static CMOS, Rationed Circuits, and Cascade Voltage Switch Logic. Dynamic Circuits and Dual- Rail Domino Multiple Output Domino Logic. BiCMOS Circuits: BiCMOS NAND Gate.		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**
Sequential Circuit Design;- Sequencing Static Circuits. Design of latches and flip flops. Conventional CMOS Latches Pulsed Latches. Conventional CMOS Flip-Flops, Resettable Latches and Flip Flops, Enabled Latches and Flip Flops.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
VHDL:-Behavioral Modeling With Concurrent Signal Assignments. Bitwise Operators. Comments and white space. Other Operator. Conditional Signal Assignment Statements. Selected Signal Assignment Statements. Basic Constructs: Blocks, Entities and Architecture. Hierarchy, Types. Library and Use Clauses. Tri-states.		
Text Books:		
1. N.H.E. Weste and D.M. Harris, CMOS VLSI design: "A Circuits and Systems Perspective" 4th Edition, Pearson Education India, 2011. 2. N.H.E. Weste and Kamran Eshraghian ,"Principles of CMOS VLSI Design, A Systems Perspective", 4th Edition, Pearson Education India, 2011.		
Reference Books:		
1. P. Allen and D. Holberg "CMOS Analog Circuit Design", Oxford University Press. 2. B. Razavi "Design of Analog CMOS Integrated Circuits", Tata McGraw-Hill. 3. P. Gray, P. Hurst, S. Lewis and R. Meyer , "Analysis and Design of Analog Integrated Circuits", Wiley Sons.		
NPTEL LINK: 1. VLSI Circuits by Prof. Srinivasan, IIT Madras https://nptel.ac.in/courses/117106092 2. Digital Systems Design by Prof. D. Roychoudhury IIT Kharagpur https://nptel.ac.in/courses/117105080		

CMOS DESIGN LAB (PCC) (Specialization Minor)					
LAB COURSE OUTLINE					
Course Title:	**CMOS DESIGN LAB**	**Short Title:**	**CDL**	**Course Code:**	**EC-615B**

Course description: This course introduces the fundamental concepts of CMOS technology through the study of MOS transistor characteristics and CMOS fabrication processes. It focuses on the design and simulation of basic and advanced CMOS circuits such as inverters, logic gates, multiplexers, latches, and flip-flops. The course also provides hands-on experience in modeling and simulating CMOS circuits using VHDL for practical digital system design.

Laboratory	Hours/week	No. of weeks	Total hours	Semester credits
	02	15	30	01

End Semester Exam(ESE)Pattern:	**Oral (OR)**

LAB COURSE CONTENT

CMOS DESIGN LAB		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
		End Semester Exam (ESE)UA:OR	**25 Marks**
Practical	**4 hours/week**	**Internal Continuous Assessment (ICA): CA**	**25 marks**

Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. Study of MOS Transistor Characteristics.
2. Design and Simulation of CMOS Inverter.
3. Design of CMOS NAND and NOR Gates.
4. Design of Multiplexer Using CMOS Logic.
5. Study of CMOS Fabrication Process.
6. Design of CMOS Latches.
7. Design of CMOS Flip-Flops.
8. VHDL Modeling of CMOS Circuits.

Guidelines for ICA:

Students must submit ICA in the form of journal. Each assignment should be well documented. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignments.

Guidelines for ESE:

ESE will be based on the laboratory experiments submitted by the students in the form of a journal. Evaluation will be based on understanding and execution.

Kavayitri Bahinabai Chaudhari
NORTH MAHARASHTRA UNIVERSITY,
JALGAON (M.S.)

Bachelor of Engineering – **Minor**

in

Data Science in Telecom

for Third Year Bachelor of Engineering

(As per NEP 2020 Guidelines)

Faculty of Science and Technology

'A' Grade
NAAC Re-Accredited
(4th Cycle)

SYLLABUS STRUCTURE & COURSE OUTLINE
For Affiliated Colleges
Semester –V & VI
W.E.F. 2026 – 27

Syllabus Structure for Specialization Minor in Data Science in Telecom: Additional Credit (Semester – V) (w.e.f. 2026 – 27)

(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ET -512C	Principles of Telecom Signal Analytics	PCC	3			3	40	60			100	3
ET -513C	Principles of Telecom Signal Analytics Lab	PCC			2	2			25	25 (OR)	50	1

Syllabus Structure for Specialization Minor in Data Science in Telecom: Additional Credit (Semester – VI) (w.e.f. 2026 – 27)

(As per NEP 2020 Guidelines)

Course Code	Name of the Course	Category	Teaching Scheme				Evaluation Scheme					Credits
							Theory		Practical		Total	
			Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE (CA)	ESE (UA)	ICA (CA)	ESE (UA)		
ET -614C	Fundamentals of Data Science and Its Application	PCC	3			3	40	60			100	3
ET -615C	Fundamentals of Data Science and Its Application Lab	PCC			2	2			25	25 (OR)	50	1

PRINCIPLES OF TELECOM SIGNAL ANALYTICS (PCC) (Specialization Minor)

COURSE OUTLINE

Course Title:	**PRINCIPLES OF TELECOM SIGNAL ANALYTICS**	**Short Title:**	**PTSA**	**Course Code:**	**ET-512C**

Course description:

This course introduces the analysis and processing of communication signals in modern telecommunication systems. It covers statistical and transform-domain signal analytics techniques used for signal characterization, detection, and performance evaluation. The course equips students with tools for both theoretical analysis and practical signal analytics in telecom applications.

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	3	**15**	**45**	**3**

Prerequisite course(s):

Signals & Systems fundamentals , Basics of Digital Communications and Probability theory

Course objectives:

1. Understand fundamental signal representations used in telecom engineering.
2. Analyse statistical properties of communication signals.
3. Evaluate performance metrics like BER and signal detection probability.
4. Apply transform-domain techniques for telecom signal insight.
5. Explore advanced signal analytics applications in modern wireless systems.

Course outcomes:

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

1. Classify and represent signals in time, frequency, and statistical domains.
2. Analyze the impact of noise and channel effects on telecom signals.
3. Compute key metrics such as PSD and correlation functions for real signals.
4. Use analytical tools (Fourier, STFT) for signal processing tasks.
5. Apply signal analytics concepts to real-world telecom systems such as 4G/5G networks.

COURSECONTENT

PRINCIPLES OF TELECOM SIGNAL ANALYTICS		**Semester:**	**V**
Teaching Scheme:		**Examination Scheme:**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE):UA**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam(ISE):CA	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction to Telecom Signal Analytics: - Types of communication signals (continuous & discrete), Signal representation in time and frequency domains, Review of Fourier Transform and spectral analysis.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Statistical Signal Analysis:- Random processes & statistical measures, Autocorrelation, cross-correlation, Power spectral density (PSD) and Wiener–Khintchine theorem.

Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**

Digital Modulation & Detection Analytics:-Signal constellation and metrics, Error performance (BER, SER) analysis, Detection theory basics (matched filter, correlator).

Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**
Noise & Channel Impact on Signals: - Noise models and effects on signals, Signal distortion analysis, Introduction to fading channel statistics.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
Analytical Tools & Applications in Telecom:- Time-frequency analysis (STFT, wavelets), Machine learning basics for signal classification, Case studies: 4G/5G signal analytics, spectrum sensing.		

Text Books:

1. B. P. Lathi & Z. Ding , "Modern Digital and Analog Communication Systems", Oxford Publications.
2. John G. Proakis& M. Salehi , "Digital Communications", McGraw-Hill Publication.

Reference Books:

1. Simon Haykin, "Communication Systems", Wiley Publication
2. Leon W. Couch "Digital and Analog Communication Systems "Pearson Publication

NPTEL Link –

1. Covers foundational signal analysis tools essential for this subject. https://onlinecourses.nptel.ac.in/noc26_ee37/preview
2. Principles of Communication Systems – I (NPTEL course) – Builds on modulation, detection, and signal properties. https://onlinecourses.nptel.ac.in/noc26_ee36/preview
3. Applied Linear Algebra for Signal 3.Processing, Data Analytics and Machine Learning Useful for advanced analytics tools .https://onlinecourses.nptel.ac.in/noc25_ee113/preview

<table>
<tr><td colspan="7">PRINCIPLES OF TELECOM SIGNAL ANALYTICS
LAB. (PCC) (Specialization Minor)</td></tr>
<tr><td colspan="7">LAB COURSE OUTLINE</td></tr>
<tr><td>Course Title:</td><td colspan="2">PRINCIPLES OF TELECOM SIGNAL ANALYTICS LAB</td><td>Short Title:</td><td>PTSA L</td><td>Course Code:</td><td>EC- 513C</td></tr>
<tr><td rowspan="2">Laboratory</td><td>Hours/week</td><td colspan="2">No. of weeks</td><td colspan="2">Total hours</td><td>Semester credits</td></tr>
<tr><td>02</td><td colspan="2">15</td><td colspan="2">30</td><td>1</td></tr>
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<tr><td colspan="3">PRINCIPLES OF TELECOM SIGNAL ANALYTICS LAB</td><td colspan="2">Semester:</td><td colspan="2">V</td></tr>
<tr><td colspan="3">Teaching Scheme:</td><td colspan="4">Examination scheme</td></tr>
<tr><td colspan="2">Practical:</td><td>2hours/week</td><td colspan="2">End semester exam(ESE) UA:OR</td><td colspan="2">25 marks</td></tr>
<tr><td colspan="3"></td><td colspan="2">Internal Continuous Assessment (ICA)CA:</td><td colspan="2">25 marks</td></tr>
<tr><td colspan="7">Concerned faculty member should suitably frame SIX laboratory assignments from the following list.

1. Time and Frequency Domain Analysis of Communication Signals.
2. Computation of Autocorrelation and Cross-Correlation.
3. Power Spectral Density (PSD) Estimation
4. Simulation of Digital Modulation Schemes.
5. BER Performance Analysis in AWGN Channel
6. Matched Filter and Signal Detection
7. Time-Frequency Analysis using STFT
8. Spectrum Sensing / Signal Classification using Basic ML</td></tr>
<tr><td colspan="7">Guidelines for ICA:</td></tr>
<tr><td colspan="7">Students must submit ICA in the form of journal. Each assignment should be well documented. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignments.</td></tr>
<tr><td colspan="7">Guidelines for ESE:</td></tr>
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</table>

FUNDAMENTALS OF DATA SCIENCE AND ITS APPLICATION(PCC) (Specialization Minor)					
COURSE OUTLINE					
Course Title:	**FUNDAMENTALS OF DATA SCIENCE AND ITS APPLICATION**	**Short Title:**	**FDSA**	**Course Code:**	**ET-614C**

Course description:

This course introduces the fundamental concepts, workflow, and real-world applications of Data Science, covering data collection, preprocessing, analysis, and interpretation. Students will learn statistical methods, basic machine learning techniques, and modern tools such as Python libraries for data handling and visualization. Emphasis is placed on transforming raw data into meaningful insights and effectively communicating results for informed decision-making across diverse application domains.

Lecture	Hours/week	No. of weeks	Total hours	Semester credits
	3	15	45	3

Prerequisite course(s):

Basic programming knowledge (preferably Python), foundational mathematics and statistics

Course objectives:

1. To understand the basics of data science and data science workflow .
2. To apply techniques for cleaning and transforming data and visualize data to identify patterns and trends.
3. To apply basic statistical methods to analyze data.
4. To Explain the basic concepts of machine learning.
5. To Utilize appropriate visualization techniques to communicate complex data patterns and relationships effectively.

Course outcomes:

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

1. Explain basics of data science and data science workflow
2. Apply techniques for cleaning and transforming data and visualize data to identify patterns and trends.
3. Apply basic statistical methods to analyze data
4. Explain the basic concepts of machine learning
5. Utilize appropriate visualization techniques to communicate complex data patterns and relationships effectively.

COURSECONTENT

		Semester:	**VI**
Teaching Scheme:		**Examination Scheme:**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE):UA**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam(ISE):CA	**40 marks**

Unit–I:	No. of Lectures: 09 Hours	Marks: 12

Introduction to Data Science and Data Science Workflow:- What is Data Science, Types of Data: Structured, Unstructured, Semi-structured, Overview of Data Science Workflow: Data Collection, Cleaning, Exploration, Modeling, Evaluation, Introduction to Python and R for Data Science, Tools for Data Science: Jupyter Notebooks, Pandas, Matplotlib, Scikit-learn.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**
Data Exploration and Preprocessing Data Cleaning:- Handling Missing Data, Outliers, and Duplicates, Data Transformation: Normalization, Scaling, Encoding Categorical Data, Data Wrangling with Pandas, Data Visualization: Using Matplotlib and Seaborn, Descriptive Statistics (Mean, Median, Mode, Variance, Standard Deviation)		
Unit–III:	**No. of Lectures: 09 Hours**	**Marks: 12**
Statistical Methods in Data Science Probability Theory Basics, Inferential Statistics: - Hypothesis Testing, p-values, Confidence Intervals, Correlation and Causality, Linear Regression and its Statistical Foundations.		
Unit–IV:	**No. of Lectures: 09 Hours**	**Marks: 12**
Introduction to Machine Learning Overview of Machine Learning: Supervised vs Unsupervised Learning, Classification Algorithms: Logistic Regression, Decision Trees, Regression Algorithms: Linear Regression, Ridge, Lasso, Model Evaluation: Confusion Matrix, Accuracy, Precision, Recall, F1-score.		
Unit–V:	**No. of Lectures: 09 Hours**	**Marks: 12**
Data Visualization and Communication Principles of Effective Data Visualization, Creating Interactive Visualizations with Plotly and Dash, Communicating Data Science Findings: Storytelling with Data Visualizing Multivariate Data.		
Text Books:		
1. Wes McKinney “Python for Data Analysis" 2. Foster Provost and Tom Fawcett "Data Science for Business"		
Reference Books:		
1. Peter Bruce, Andrew Bruce, Peter Gedeck “Practical Statistics for Data Scientists" 2. Aurélien Géron "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow"		
NPTEL LINK:- 1. Data Science for Engineers, IIT Madras by Prof. Ragunathan Rengasamy, Prof. Shankar Narasimhan, https://nptel.ac.in/courses/106106179 2. Introduction to Machine Learning by Prof. Sudeshna Sarkar IIT Kharagpur https://nptel.ac.in/courses/106105152		

FUNDAMENTALS OF DATA SCIENCE AND ITS APPLICATION LAB (PCC) (Specialization Minor)					
LAB COURSE OUTLINE					
Course Title:	**FUNDAMENTALS OF DATA SCIENCE AND ITS APPLICATION LAB**	**Short Title:**	**FDSAL**	**Course Code:**	**ET- 615C**
Laboratory	**Hours/week**	**No. of weeks**	**Total hours**		**Semester credits**
	02	15	30		1
End Semester Exam(ESE)Pattern:		**Oral (OR)**			
LAB COURSE CONTENT					
DATA SCIENCE AND ITS APPLICATION		**Semester:**	**VI**		
Teaching Scheme:		**Examination scheme**			
Practical:	**2hours/week**	**End semester exam(ESE) :UA(OR)**			**25 marks**
		Internal Continuous Assessment (ICA):CA			**25 marks**

Concerned faculty member should suitably frame SIX laboratory assignments from the list given below.

1. Study of Data Science Workflow using Python.
2. Data Cleaning and Preprocessing using Pandas.
3. Descriptive Statistics and Data Visualization.
4. Data Wrangling and Transformation.
5. Statistical Analysis and Hypothesis Testing.
6. Linear Regression and Correlation Analysis.
7. Classification and Regression using Machine Learning Algorithms.
8. Model Evaluation and Interactive Data Visualization.

Guidelines for ICA:

Students must submit ICA in the form of journal. Each assignment should be well documented. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignments.

Guidelines for ESE:

ESE will be based on the laboratory assignments submitted by the students in the form of journal. Evaluation will be based on the understanding and execution.