B. Tech

Curriculum (2024) and Syllabus-Semester III & IV

Electronics and Communication Engineering

Branch Code: ECE

(SHR/AC/Auto/ Acad. Council /B.Tech/3/Syll./ECE/S3-S4)

Recommended by BoS on 12/06/2025

Approved by Academic Council on 05/07/2025

THIRD SEMESTER (July-December)												
Sl. No:	**Slot**	**Course Code**	**Course Type**	**Course Title (Course Name)**	**Credit Structure**			**Total Marks**			**Credits**	**Hrs. / Week**
					L	**T**	**P**	**R**	**CIA**	**ESE**		
1	A	24MAT321	BSC	Complex Analysis and Partial Differential Equations	3	0	0	0	40	60	3	3
2	B	24ECT302	PCC	Analog Circuits	3	1	0	0	40	60	4	4
3	C	24ECT303	PCC	Solid State Devices	3	1	0	0	40	60	4	4
4	D	24ECR304	PCC-PBL	Logic Circuit Design	3	0	0	1	50	50	4	4
5	E	24HUT005	HMC	Engineering Economics	2	0	0	0	50	50	2	2
6	F	24EST306	ESC	Applied Data Science & Artificial Intelligence	3	1	0	0	40	60	4	4
7	L	24ECL307	PCL	Analog Circuits Lab	0	0	3	0	50	50	2	3
8	Q	24ECL308	PCL	Logic Circuit Design Lab	0	0	3	0	50	50	2	3
9	J*	24SEK10N	SEC	Skill Enhancement Course 3							1	
10	R/ M	24ECG3XX	VAC	Remedial/Minor Course							4*	4*
Total											**26/ 30***	**27/ 31***

FOURTH SEMESTER (January-June)												
Sl. No:	**Slot**	**Course Code**	**Course Type**	**Course Title (Course Name)**	**Credit Structure**				**Total Marks**		**Credits**	**Hrs./ Week**
					L	**T**	**P**	**R**	**CIA**	**ESE**		
1	A	24MAT421	BSC	Probability Distributions, Numerical Methods and Transforms	3	0	0	0	40	60	3	3
2	B	24ECT402	PCC	Signals and Systems	3	1	0	0	40	60	4	4
3	C	24ECT403	PCC	Linear Integrated Circuits	3	1	0	0	40	60	4	4
4	D	24ECR404	PCC-PBL	Microcontrollers & Embedded Systems	3	0	0	1	50	50	4	4
5	F	24ECE41N	PE	PE-1	3	0	0	0	40	60	3	3
6	L	24ECL406	PCL	Linear Integrated Circuits Lab	0	0	3	0	50	50	2	3
7	Q	24ECL407	PCL	Microcontroller Lab	0	0	3	0	50	50	2	3
8	I*	24PWT208	PW	UHV II, Life Skills & Community work	1	0	0	0	100	--	1	1
9	J*	24SEK10N	SEC	Skill Enhancement Course 4							1	
10	R/M/H	24ECG4XX/ 24ECH4XX	VAC	Remedial/Minor/ Honours Course							4*	4*
Total											**24/ 28***	**25/ 29***

PROGRAM ELECTIVE I: 24ECE41N

Slot	Course Code	Courses	L-T-P-R	Hours	Credit
F	24ECE411	Electronic Instrumentation	3-0-0-0	3	3
	24ECE412	Power Electronics	3-0-0-0		3
	24ECE413	Sensors and Actuators	3-0-0-0		3
	24ECE414	Machine Learning	3-0-0-0		3
	24ECE415	Digital Systems and VLSI Design	3-0-0-0		3
	24ECE416	Object Oriented Programming#	3-1-2-0	6	5

 # Higher credit elective

SEMESTER-III
SYLLABUS

24MAT321	Complex Analysis & Partial Differential Equations	L	T	P	R	C	Year of Introduction
		3	0	0	0	3	2024

Preamble: The course enables the students to understand basic concepts and tools of Partial Differential equations and Complex Analysis. Topics like Partial Differential Equations, Complex Integration, and Residues are included. This course helps the learners to model and analyze physical phenomena involving continuous changes of variables or parameters with the help of modern tools and has applications across all engineering domains.

Prerequisite: A basic course in multivariable calculus and complex numbers.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Solve partial differential equations which are widely used in different engineering situations, modeling and applying partial differential equations in the analysis of various physical phenomena **[Apply]**
CO 2	Apply complex variables and conformality to transform functions from one domain to another .**[Apply]**
CO 3	Apply indefinite integration and substitution of limits in the context of complex functions, integrating over paths and contours in the complex plane. **[Apply]**
CO 4	Apply residue theory to solve real integrals, and how this connection enhances the evaluation of integrals in both real and complex domains. **[Apply]**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11
CO 1	3	3	3					2			2
CO 2	2	3									2
CO 3	3	3									2
CO 4	3	3									2

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	√	√	√	√
Understand	√	√	√	√
Apply	√	√	√	√

Analyses				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-R]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
	5	10	12.5	12.5	40

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	2.5 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	8 Questions, each question carries 3 marks Marks: (3x8 =24 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of two sub divisions. Each question carries 9 marks. Marks: (9x4 = 36 marks)	60

SYLLABUS

MODULE I: [Partial Differential Equations & Applications](9 Hrs)

(Text 2-Relevant portions of sections 17.1, 17.2, 17.3, 17.4, 17.5,18.2,18.3,18.4, 18.5)

Partial differential equations, Formation of partial differential equations –elimination of arbitrary constants and arbitrary functions, Solutions of partial differential equations- Equations solvable by direct integration, Linear equations of the first order- Lagrange's linear equation, Solution of equation by method of separation of variables, One-dimensional wave equation- vibrations of a stretched string, One- dimensional heat equation (problems only).

Self Study (14 hours):-

1. Derivation of PDEs from real-world physics problems (e.g., heat equation, wave equation)
2. Relevance of PDE in your branch of study.
3. Narrate different methods to solve nonlinear equations with examples.
4. Review three or four of the most important PDEs and their main applications.
5. Solve five problems by the method of separation of variables.

MODULE II: [Complex Variable – Differentiation](9 Hrs)

(Text 1: Relevant portions of sections 13.3, 13.4, 17.1, 17.2 , 17.4)

Complex function, limit, continuity, derivative, analytic functions, Cauchy Riemann equations, harmonic functions, finding harmonic conjugate, Conformal mappings- mappings w = z2 , w = ez , w = 1z , w = sinz (problems based on these transformations need to be discussed)

Self Study (13 hours) :-

1. Write some analytic functions with proof.
2. Write notes on Mobius transformations with examples.
3. Discuss the conformal mapping of cosz.
4. Write the properties of the Inversion w = 1/z.
5. Solve five problems using the Cauchy-Riemann equations.

MODULE III: [Complex Variable – Integration](9 Hrs)

(Text 1- Relevant topics from sections 14.1, 14.2, 14.3, 14.4)

Complex integration, Line integrals in the complex plane, Indefinite integration and substitution of limit, Contour integrals, Cauchy's integral theorem (without proof) on simply connected and multiply connected domain, Cauchy Integral formula (without proof), Cauchy Integral formula for derivatives of an analytic function

Self-Study (14 hours): -

1. Write the basic properties of a complex line integral.
2. Integrate f(z) counter clockwise around the unit circle. Indicate whether Cauchy's integral theorem applies. Show the details.: f(z) = 1/(2z - 1).
3. Review the situations where Cauchy's integral formula and theorem are used in problems with suitable examples.
4. Solve five problems using Cauchy's integral formula.

MODULE IV: [Complex Variable – Residue Integration] (9 Hrs)

(Text 1- Relevant topics from sections 16.2, 16.3,16.4)

Zeros of analytic functions, singularities, poles, removable singularities, essential singularities, Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral using residue theorem, Residue integration of real integrals – integrals of rational functions of $cos\theta$ and $sin\theta$

Self-Study (13 hours): -

1. Importance of singularities in your branch of study.
2. Solve five problems using the concept of poles.
3. Write a few examples for Laurent's series.
4. Explain the process of solving improper integrals with examples.

Text books

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10thEdition, John Wiley & Sons, 2016.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 43rd Edition,2015

Reference books

1. Peter V. O'Neil, Advanced Engineering Mathematics, Cengage, 7th Edition, 2012.

NPTEL/SWAYAM Courses for reference:

1.Nandakumaran, A. K. (2020). *Complex analysis*. National Programme on Technology Enhanced Learning (NPTEL), IIT,Madras. https://archive.nptel.ac.in/courses/111/106/111106141/

2.Venkata Balaji, T.E. (2020). *Advanced Complex Analysis -Part 1: Zeros of Analytic Functions, Analytic Continuation, Monodromy, Hyperbolic Geometry, and the Riemann Mapping Theorem*.National Programme on Technology Enhanced Learning(NPTEL),IIT,Madras. https://archive.nptel.ac.in/courses/111/106/111106084/NPTEL+1btechguru.com+1

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours [36 hours]
	MODULE 1 [9 hours]	
1.1	Partial differential equations, Formation of partial differential equations - elimination of arbitrary constants	1
1.2	Formation of partial differential equations -elimination of arbitrary functions	1
1.3	Solutions of partial differential equations-Equations solvable by direct integration	1
1.4	Linear equations of the first order- Lagrange's linear equation	1

1.5	Solution of equation by method of separation of variables	1
1.6	One- dimensional wave equation- vibrations of a stretched string	2
1.7	One- dimensional heat equation	2
	MODULE II [9 hours]	
2.1	Complex function, limit, continuity, derivative, analytic functions	1
2.2	Cauchy-Riemann equations	2
2.3	harmonic functions, finding harmonic conjugate	2
2.4	Conformal mappings- mappings w = z2	1
2.5	Conformal mappings- w = ez	1
2.6	Conformal mappings- w = 1z	1
2.7	Conformal mappings- w = sinz	1
	MODULE III [9 hours]	
3.1	Complex integration, Line integrals in the complex plane	1
3.2	Indefinite integration and substitution of limit	1
3.3	Contour integrals, Cauchy's integral theorem (without proof) on simply connected connected domain	2
3.4	Contour integrals, Cauchy's integral theorem (without proof) on multiply connected domain	1
3.5	Cauchy Integral formula (without proof)	2
3.6	Cauchy Integral formula for derivatives of an analytic function	2
	MODULE IV [9 hours]	
4.1	Zeros of analytic functions	1
4.2	singularities, poles	1
4.3	removable singularities, essential singularities	1
4.4	Residues	1
4.5	Cauchy Residue theorem (without proof)	1
4.6	Evaluation of definite integral using residue theorem	2
4.7	Residue integration of real integrals – integrals of rational functions of $cos\theta$ and $sin\theta$	2

CO Assessment Questions

CO1	1. Form the PDE by eliminating the arbitrary function 'f' from the equation z = f(x-y). **[Apply]** 2. Solve the one-dimensional heat equation subject to the initial condition u(x,0) = $\sin^2 x$. **[Apply]** **Team Work**: Discuss and present solutions to PDEs, highlighting the physical significance and applications of the results.
CO2	1. Show that if u is harmonic and v is a harmonic conjugate of u, then u is a harmonic conjugate of -v. **[Understanding]** 2.Why do the images of the straight lines x=constant and y=constant under a mapping by an analytic function intersect at right angles? The same question for the curves z =constant and Arg z = constant. Are there exceptional points? **[Apply]** 3.Find the fixed point of w =a z +b.**[Understanding]** **Team Work:** As a group, analyze the behavior of the transformation w=1/z on different regions in the complex plane, such as the upper half-plane and the unit disk. What are the effects on these regions under the transformation?
CO3	1.What is the significance of Cauchy's Integral Theorem for integrals over closed paths in a simply connected domain?**[Apply]** 2. Evaluate the indefinite integral of the complex function f(z)=e2zand express the result in terms of z.**[Apply]** 3.Integrate counterclockwise around the unit circle CSin zz4 dz**[Apply]** **Team Work:**In your group, work together to prove that for an analytic function f(z), the integral ∫f(z) dz= 0 for any closed path C inside a simply connected domain.
CO4	1. Evaluate the integral 02πdθ3-2cosθ**[Apply]** 2.Consider the function f(z)= 1z2+1 . Identify and classify the singularities of this function**. [Analyze]** **Team Work:** Investigate the function f(z)= z2+1z - 1(z + 2) . Identify and classify all singularities of the function.

Prepared By,

Ms. Swapna Joseph
Asst.Prof, ASH

24ECT302	ANALOG CIRCUITS	L	T	P	R	C	Year of Introduction
		3	1	0	0	4	2024

Preamble: This course aims to develop the skill of analyze and design of different types of analog circuits covering RC circuits, transistor and MOSFET biasing, amplifier design, filters, regulators, feedback, and oscillators using discrete electronic components.

Prerequisite: 24EST104 Fundamentals of Electrical & Electronics Engineering

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

CO 1	Design wave shaping circuits using first order RC networks and diodes.**(Apply/Design)**
CO 2	Design and analyze BJT amplifiers using equivalent models .**(Apply/Analyze)**
CO 3	Design and analyze MOSFET amplifiers using equivalent models .**(Apply/Analyze)**
C04	Understand the principles of power amplifiers and feedback in the design of oscillators.**(Understanding)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3								2
CO2	3	3	3								2
CO3	3	3	3								2
C04	3	3									2

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	√	√	√	√
Understand	√	√	√	√
Apply	√	√	√	√
Analyze	√	√		√
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-R]	Lecture [L]				
	Attendance	Assignment	Test-1	Test-2	Total Marks

3-1-0-0	5	10	12.5	12.5	40

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	2.5 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	8 Questions (2 Questions from each module), each question carries 3 marks Marks: (3x8 =24 marks)	2 questions will be given from each module, out of which 1 should be answered. Each question can have a maximum of two sub-divisions. Each question carries 9 marks. Marks: (9x4 = 36 marks)	60

SYLLABUS

MODULE I (13 hours)

First order RC differentiating and integrating circuits, First order RC low pass and high pass filters. Diode Clipping circuits - Positive, negative and biased clipper. Diode Clamping circuits - Positive, negative and biased clamper.

Transistor biasing: Need, operating point, concept of DC load line, fixed bias, self bias, voltage divider bias, bias stabilization.

Self Study(20 hrs):

1. Simulate waveforms using LTSpice.
2. Analyze frequency response using simulation.
3. Derive operating point and plot DC load line.
4. Analyze how RC filters or transistor biasing are used in real-world devices (e.g., audio systems, sensors).

MODULE II (13 hours)

RC coupled amplifier (CE configuration) – need of various components and design, Concept of AC load lines, voltage gain and frequency response. Small signal analysis of CE configuration using small signal hybrid-pi model for mid frequency and low frequency. (gain, input and output impedance). High frequency equivalent circuits of BJT, Miller effect, Analysis of high frequency response of CE amplifier

Linear Voltage Regulators: Types of voltage regulators- series and shunt -working and design, load & line regulation, short circuit protection and fold back protection.

Self-Study (20 hrs):

1. Review case studies related to RC coupled amplifiers or BJT amplifiers used in real-world applications (e.g., audio systems, communication devices).

2. Read and summarize datasheets and application notes for BJT transistors used in RC coupled amplifiers (e.g., 2N3904), focusing on parameters relevant to CE amplifier design such as hFE, fT, and VCE(sat).

3. Study real-world amplifier applications in communication circuits or audio preamps to see how CE amplifiers are used and how AC coupling and biasing affect performance.
4. In teams, design and simulate an RC coupled CE amplifier using circuit simulation tools (LTspice, Multisim), analyze gain, bandwidth, and frequency response, then present an optimized design based on specific application needs.

MODULE III (9 hours)

MOSFET circuits at DC, MOSFET as an amplifier,Frequency response for MOSFET amplifiers , Biasing of discrete MOSFET amplifier, small signal equivalent circuit. Small signal voltage and current gain, input and output impedance of CS configuration. CS stage with current source load, CS stage with diode-connected load.
Multistage amplifiers - effect of cascading on gain and bandwidth. Cascode amplifier.

Self-Study (15 hrs) :

1. Study real-world MOSFET amplifier applications in analog front-end circuits (e.g., audio preamps, sensor interfacing) to understand how biasing and MOSFET selection affect performance.
2. Analyze DC biasing techniques (e.g., voltage divider, constant current bias) for discrete MOSFET amplifiers. Verify bias points using simulation tools like LTspice or Proteus.
3. Build and test a discrete MOSFET amplifier, adjusting the gate bias to explore the effect on the drain current and output voltage. Record V-I characteristics under different operating points.

MODULE IV (12 hours)

Effect of positive and negative feedback on gain, frequency response and distortion. The four basic feedback topologies, Analysis of discrete BJT circuits in voltage-series and voltage-shunt feedback topologies - voltage gain, input and output impedance.
Oscillators: Classification, Barkhausen criterion for oscillation, Wien bridge oscillator, Hartley and Crystal oscillator. (working principle and design equations of the circuits; analysis of Wien bridge oscillator only required).
Power amplifiers: Classification and comparison of different type of power amplifiers (no analysis required)

Self-Study (18 hrs):

1. Read and summarize technical notes on amplifier feedback (e.g., from TI, Analog Devices) to understand how positive and negative feedback influence gain stability, bandwidth, and distortion.
2. Study real-world circuits (e.g., operational amplifier-based audio systems) that utilize different types of feedback. Identify where feedback improves linearity and bandwidth or introduces instability.

3. In teams, build and simulate discrete BJT amplifiers with and without feedback (voltage-series and voltage-shunt). Present comparative data on gain, bandwidth, and THD (total harmonic distortion).

Textbooks

1. Robert Boylestad and L Nashelsky, "Electronic Devices and Circuit Theory", 11/e Pearson, 2015.
2. Sedra A. S. and K. C. Smith, "Microelectronic Circuits", 6/e, Oxford University Press, 2013.

Reference books

1. Razavi B., "Fundamentals of Microelectronics", Wiley, 2015
2. Neamen D., "Electronic Circuits, Analysis and Design", 3/e, TMH, 2007.
3. David A Bell, "Electronic Devices and Circuits", Oxford University Press, 2008.
4. Rashid M. H., "Microelectronic Circuits - Analysis and Design", Cengage Learning, 2/e,2011
5. Millman J. and C. Halkias, "Integrated Electronics", 2/e, McGraw-Hill, 2010.

NPTEL/SWAYAM Courses for reference:

1.NPTEL:Analog Electronic Circuits,IIT Madras
https://archive.nptel.ac.in/courses/108/106/108106188/

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours [47 hours]
	MODULE 1 [11 hours]	
1.1	Analysis and design of RC differentiating and integrating circuits	2
1.2	Analysis and design of First order RC low pass and high pass filters	2
1.3	Clipping circuits - Positive, negative and biased clipper	2
1.4	Clamping circuits - Positive, negative and biased clamper	1
1.5	Need of biasing, operating point, bias stabilization, concept of load line	3
1.6	Design of fixed bias, self bias, voltage divider bias.	3
	MODULE II [13 hours]	
2.1	RC coupled amplifier (CE configuration) – need of various components and design, Concept of AC load lines.	2
2.2	Small signal analysis of CE configuration using small signal hybrid π model for mid frequency. (gain, input and output impedance).	3

2.3	High frequency equivalent circuits of BJT, Miller effect, Analysis of high frequency response of CE amplifiers. voltage gain and frequency response	4
2.4	Types of voltage regulators- series and shunt -working and design	2
2.5	load & line regulation, short circuit protection and fold back protection.	2
MODULE III [9 hours]		
3.1	MOSFET circuits at DC, MOSFET as an amplifier, Biasing of discrete MOSFET amplifier,Frequency response for MOSFET amplifiers	2
3.2	Small signal equivalent circuit. Small signal voltage and current gain, input and output impedances of CS configuration.	3
3.3	CS stage with current source load, CS stage with diode-connected load.	2
3.4	**Multistage amplifiers** - effect of cascading on gain and bandwidth. Cascode amplifier	2
MODULE IV [12 hours]		
4.1	Properties of positive and negative feedback on gain, frequency response and distortion.	2
4.2	Analysis of the four basic feedback topologies	2
4.3	Analysis of discrete circuits in each feedback topologies -voltage gain, input and output impedance	3
4.4	Classification, Criterion for Oscillation	1
4.5	Wien bridge oscillator, Hartley and Crystal oscillator. (working principle and design equations of the circuits; analysis not required).	2
4.6	**Power amplifiers**: Classification and comparison of different type of power amplifiers(no analysis required)	2

CO Assessment Questions

CO-1	3-Mark Questions 1. What is the need for biasing a transistor? What factors are to be considered for selecting the operating point Q?*(Understanding)* 9-Mark Questions 1. Design a high pass filter for a cutoff frequency of 5KHz. Plot the frequency response indicating roll off rate in terms of dB/decade and dB/octave. Also,draw output waveform for triangular input at i) 500Hz ii) 5KHz iii) 10KHz *(Apply)* 2. Design a clamper circuit to clamp a 10Vpp sine wave so that its negative peak is clamped at +2V. Assume diode drop is 0.7V. Draw

	and explain the output waveform and transfer characteristics.*(Apply)*
CO-2	3-Mark Questions 1. Explain the hybrid-π parameters of BJT in CE configuration. *(Understanding)* 2. State Miller's theorem.*(Understanding)* 3. Obtain the hybrid- π model for a single transistor with a resistive load RL.*(Understanding)* 9-Mark Questions 1. Design an RC coupled amplifier for a gain of 200, given that Vcc=15V and Ic=3.2mA and required input impedance is 1.44KΩ. Find the lower cutoff frequency of the amplifier. Assume capacitor values appropriately if necessary.*(Apply)* 2. Short circuit CE current gain of transistor is 25 at a frequency of 2 MHz if fβ = 200 kHz. Calculate (i) fT (ii) hfe (iii) |Ai| at a frequency of 10 MHz and 100 MHz.*(Apply)* Sample assignment questions: 1. Design amplifier circuits using BJT and MOSFET and simulate to obtain gain vs. frequency plots.
CO-3	3-Mark Questions 1. Draw the block diagram of a multistage amplifier with n number of stages and give an expression for its overall voltage gain. *(Understanding)* 2. Explain with a diagram common source MOSFET stage with diode-connected load. *(Understanding)* 3. Three stages of individual RC coupled amplifiers having mid band gain of 80 with lower cutoff frequency of 100Hz and upper cutoff frequency of 300MHz are cascaded. Find the resultant gain and cutoff frequencies. *(Understanding)* 4. Given K=0.4mA/V2 and ID(ON) = 3.5mA with VGS(ON) = 4V. Determine the value of VTH. (*Apply)* 9-Mark Questions 1. Calculate the drain current and drain-to-source voltage of a common source circuit with an n-channel enhancement mode MOSFET. Find the power dissipated in the transistor. R1=22KΩ, R2=10KΩ, RD=6.8KΩ, VDD=8V, VT=1V, Kn=0.1mA/V2*(Apply)*

	2. What are the effects of cascading in gain and bandwidth of an amplifier?*(Analyze)*
CO-4	3-Mark Questions 1. List any three advantages of negative feedback in amplifiers. *(Understanding)* 2. State Barkhausen criteria. How it is achieved in Wien bridge oscillators? *(Understanding)* 9-Mark Questions 1. A voltage series negative feedback amplifier has a voltage gain without feedback A =500. Input and output resistances are 3 KΩ and 20 KΩ respectively, feedback factor β = 0.01. Calculate the voltage gain Af, Rif, Rof of the amplifier with feedback. *(Understand)* 2. Explain the working principle of crystal oscillator. Draw the equivalent circuit of a crystal. *(Understand)* Sample assignment questions: 1. Analyze the impact of negative feedback on the bandwidth, gain stability, and distortion in a BJT amplifier. Use circuit simulations or practical measurements to justify your answer. 2. Compare and contrast voltage-series and voltage-shunt feedback topologies in terms of gain, input impedance, and output impedance. Which topology would you recommend for a high-impedance sensor interface and why?

Prepared by
Ms.Reshma P S, AP,ECE

24ECT303	**SOLID STATE DEVICES**	**L**	**T**	**P**	**R**	**C**	**Year of Introduction**
		3	**1**	**0**	**0**	**4**	**2024**

Preamble: This course explains the physical processes and working principles of semiconductor devices, while relating the device performance to material parameters and design criteria.

Prerequisite: 24PHC222- Physics for Electrical Science	
Course Outcomes: After the completion of the course, the student will be able to	
CO 1	Apply the basic laws of solid state physics to understand the properties of semiconductor materials**. [Apply]**
CO 2	Outline the different carrier transport mechanisms in extrinsic semiconductors and apply the concept of semiconductor physics to solve the current components in semiconductor devices. **[Understand, Apply]**
CO 3	Analyse the response and characteristics of various electronic devices under different biasing conditions .**[Analyze]**
CO 4	Analyze the effects of scaling in semiconductor devices. **[Analyze]**

CO - PO MAPPING

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember			√	
Understand	√	√	√	√
Apply	√	√	√	√
Analyze	√	√	√	√
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-R]	Lecture [L]				
	Attendance	Assignment	Test-1	Test-2	Total Marks
3-1-0-0	5	10	12.5	12.5	40

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	2.5 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	8 Questions (2 Questions from each module), each question carries 3 marks Marks: (3x8 =24 marks)	2 questions will be given from each module, out of which 1 should be answered. Each question can have a maximum of two sub-divisions. Each question carries 9 marks. Marks: (9x4 = 36 marks)	60

SYLLABUS

MODULE I (14 hours)

Review of Semiconductor physics: Energy band diagram**,** Equilibrium and steady state conditions, Electron Effective mass ,E-K diagram, The Fermi level, Equilibrium concentration of electrons and holes-Mass action law.
Excess carriers in semiconductors: Generation and recombination mechanisms of excess carriers, quasi-Fermi levels.
Carrier transport in semiconductors: Drift, conductivity and mobility, Diffusion, Einstein relations, Continuity and Diffusion equations, Diffusion length.

Self-Study (22 hrs):

1. Watch a video/animation showing band formation from atomic orbitals.
2. Write short notes explaining "effective mass" in your own words.
3. Read a datasheet of intrinsic carrier concentration values.
4. Simulate carrier concentration profiles using any basic tool (e.g., Python).

MODULE II (12 hours)

PN junctions: PN junction at equilibrium, Forward and reverse bias junctions, Contact potential, Electrical Field, Potential and Charge distribution at the junction, Biasing and Energy band diagrams, Ideal diode equation (qualitative only) ,Small-signal and large-signal models.
Metal Semiconductor contacts: Rectifying and ohmic contacts, current voltage characteristics.

Self-Study (19 hrs):

1. Draw the depletion region, label carrier movement, and simulate formation using free TCAD demo tools (like NanoHub or Silvaco ATLAS demo).
2. Know how the electric field is set up across a junction.
3. Use LTSpice to build a simple diode rectifier and compare small vs. large signal responses.
4. Understand the contrast between ohmic and rectifying contacts.

5. Solve numerical problems related to the different concepts.

MODULE III (9 hours)

Bipolar junction transistor: Fundamentals of BJT operation ,Base width modulation, Distribution of carrier concentration, Current components in BJT, Bipolar Transistor Models and Characteristics.

Self-Study (15 hrs):

1. Draw energy band diagram of active mode BJT.
2. Practice using the equations to compute terminal currents.
3. Learn transistor action (why it's called a current amplifier)
4. Draw the Ebers-Moll model for NPN
5. Label all terminal currents and voltages
6. Analyze common-emitter configuration and plot gain using LTSpice.

MODULE IV(11 hours)

Ideal MOS capacitor: Energy band diagrams at equilibrium, accumulation, depletion and inversion, CV characteristics, effects of real surfaces , threshold voltage.

MOSFET- Drain current equation of enhancement type MOSFET (derivation)- linear and saturation region, transfer characteristics.**MOSFET scaling**: Need for scaling, constant voltage scaling and constant field scaling.**Short channel effects in MOSFETs:** Channel length modulation, Drain Induced Barrier Lowering, Velocity Saturation, and Hot Carrier Effects.

Self-Study (18 hrs):

1. Plot simplified C-V curve (accumulation, depletion, inversion regions) based on given parameters.
2. Read and summarize datasheets of Schottky diodes and MOSFETs, focusing on electrical parameters and device structures.
3. Draw energy band diagrams of MOS capacitor under different bias conditions, explaining accumulation, depletion, and inversion qualitatively.
4. Simulate MOSFET I-V characteristics in LTSpice and compare theoretical and simulated drain current values.
5. Use simple MOSFET models in simulation tools (e.g., LTSpice) to observe effects of changing device dimensions and voltages.
6. Given original device dimensions and voltages, calculate scaled device parameters using constant voltage and constant field scaling rules.

Textbook

1. Ben Streetman, Sanjay Banerjee, Solid State Electronic Devices, 7ED, Pearson, 2014.
2. K. Masu and S. Amakawa, Elementary Semiconductor Device Physics: Understanding Energy Band Formation Using Circuit Theory. Boca Raton, FL: CRC Press, 2025.
3. Behzad Razavi, Fundamentals of Microelectronics, Wiley, 2008.
4. Chenming C. Hu, Modern Semiconductor Devices for Integrated Circuits, Pearson Education, 2010.
5. Sze, S. M., Lee, M. K., Semiconductor Physics and Devices: An Indian Adaptation, 3rd Edition, Wiley, 2021, ISBN-10: 8126579746, ISBN-13: 978-8126579746
6. Kano, K., Kanaan, N., Semiconductor Devices, Prentice Hall, 1998
7. T. H. Lee, "A Review of MOS Device Physics," Handout #2, EE214 Fall 2001 (1996; rev. Sept 26, 2001), Columbia University.
8. B. Van Zeghbroeck, Principles of Semiconductor Devices, 1st ed. Colorado:University of Colorado,2004.[Online].Available:https://convexoptimization.com/TOOLS/Zeghbroeck2004.pdf

Reference books

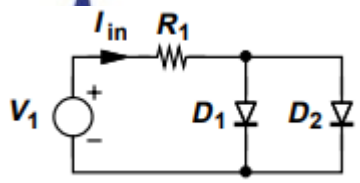
1. A.S. Sedra & K.C. Smith, Microelectronic Circuits (6/e), Oxford, 2010.
2. Robert L. Boylestad and Louis Nashelsky, Electronic Devices and Circuit Theory, 11th Edition, Pearson Education, 2013, ISBN: 013250457X
3. Achuthan, K. N. Bhat, Fundamentals of Semiconductor Devices, 1st Edition, McGraw Hill, 2017, ISBN-10: 007061220X, ISBN-13: 978-0070612204
4. Sze, S. M., Physics of Semiconductor Devices, 3rd Edition, John Wiley, 2015, ISBN-10: 0470873670, ISBN-13: 978-0470873670
5. Sze, S. M., Semiconductor Devices: Physics and Technology, 3rd Edition, John Wiley, 2016, ISBN-10: 1118953619, ISBN-13: 978-1118953612

NPTEL/SWAYAM Courses for reference:

1. NPTEL :: Solid State Devices, IIT Madras
   https://nptel.ac.in/courses/11710609
2. Razavi Electronics , Behzad Razavi
   Razavi Electronics

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours [46 hours]
	MODULE 1 [14 hours]	
1.1	Energy band diagram, Equilibrium and steady state conditions	2
1.2	Effective mass , E-K diagram, The Fermi level	2
1.3	Equilibrium concentration of electrons and holes-Mass action law.	2
1.4	Generation and recombination mechanisms of excess carriers, quasi-Fermi levels.	1

1.5	Drift, conductivity and mobility	2
1.6	Diffusion, Einstein relations	3
1.7	Continuity equations, Current flow equations, Diffusion length	2
MODULE II [12 hours]		
2.1	PN junction at equilibrium, Forward and reverse bias junctions,Contact potential, Electrical Field, Potential and Charge distribution at the junction	3
2.2	Biasing and Energy band diagrams	3
2.3	Ideal diode equation (qualitative analysis only),Small-signal and large-signal models.	3
2.4	Metal Semiconductor contacts: Rectifying and ohmic contacts, current voltage characteristics.	3
MODULE III [9 hours]		
3.1	Fundamentals of BJT operation , Base width modulation	2
3.2	Distribution of carrier concentration, Current components in BJT	3
3.3	Bipolar Transistor Models and Characteristics.	4
MODULE IV [11 hours]		
4.1	Ideal MOS capacitor: Energy band diagrams at equilibrium, accumulation, depletion and inversion.	3
4.2	CV characteristics, effects of real surfaces , threshold voltage.	2
4.3	MOSFET- Drain current equation of enhancement type MOSFET (derivation)- linear and saturation region, transfer characteristic	3
4.4	MOSFET scaling: Need for scaling, constant voltage scaling and constant field scaling.	1
4.5	Short channel effects in MOSFETs: Channel length modulation, Drain Induced Barrier Lowering, Velocity Saturation, and Hot Carrier Effects.	2
CO Assessment Questions		
CO-1	1. Given a silicon sample doped with 10 phosphorous atoms/cm^3, calculate the equilibrium hole concentration at 300 K.Identify the position of the Fermi level relative to the conduction band edge and intrinsic Fermi level.Draw the energy band diagram and discuss the changes that occur in the diagram as the phosphorous doping concentration increases. What do these changes imply about the material's electrical properties? 2. With suitable energy band diagrams explain direct recombination and indirect recombination of excess carriers . 3. Reason out qualitatively how, in a semiconductor under equilibrium, the pn product remains constant = ni^2 with changes in doping.	

CO-2	1. Analyse how the drift velocity vary with applied electric field in a silicon semiconductor. 2. Show that the current density expression ,Jn = qnμnE + qDn∇n can be expressed in the compact form, Jn = nμn∇εfn using the relations E = (1/q)∇εc, Dn= (kT/q) μn. Derive an analogous relation for Jp in terms of εfp.
CO-3	1. An abrupt p-n junction made of Silicon has Na=10^{18} cm^{-3} on the p-side and Nd=5x$10^{15}$$cm^{-3}$ on the n-side. At 300K, calculate built-in potential using its expression. 2. A metal layer is deposited over the Si layer. The work function of the metal is 4.6 eV, electron affinity of Si is 4 eV and acceptor doping level of 10^{18} cm^{-3}. Draw the equilibrium band diagram and mark off the Fermi level, the band edges, and the vacuum level. Is this a Schottky or ohmic contact, and why? By how much should the metal work function be altered to change the type of contact? 3. With the help of necessary band diagrams, explain equilibrium, accumulation,depletion and inversion stages of a MOS capacitor. 4. In the circuit given below, D1 and D2 have different cross section areas but are otherwise identical. Determine the current flowing through each diode.  5. A bipolar transistor having IS = 5x10^{18} A is biased in the forward active region with VBE = 750 mV. If the current gain varies from 50 to 200 due to manufacturing variations, calculate the minimum and maximum terminal currents of the device
CO-4	1. Given a MOSFET's original dimensions and parameters, apply scaling rules and compare drain current before and after scaling. 2. A mobile processor design is transitioning from 65 nm to 28 nm technology node.Analyze the trade-offs the design team must consider due to scaling.(power, speed, reliability, leakage)

Prepared by,

Chinchu Jose

Assistant Professor,

Department of ECE.

24ECR304	LOGIC CIRCUIT DESIGN	L	T	P	R	C	Year of Introduction
		3	0	0	1	4	2024

Preamble: This course provides a comprehensive introduction to digital logic design, covering fundamental concepts such as number systems, Boolean algebra, combinational and sequential circuits, finite state machines, and logic families. It equips students with the theoretical knowledge and practical skills needed to design efficient digital systems and implement them using tools like Verilog HDL.

Prerequisite:
24MAT121: Linear Algebra, Differential Equations & Laplace transforms.
24EST023 : Fundamentals of Electrical & Electronics Engineering

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

CO 1	Understand number systems, perform conversions, and apply Boolean algebra techniques to simplify logical expressions for digital circuit realization. **[Understand]**

CO 2	Design combinational logic building blocks and implement them using both logic gates and HDL in structural and behavioral styles. **[Apply]**
CO 3	Model and implement sequential circuits including flip-flops, latches, counters, shift registers and simulate using HDL**. [Apply]**
CO 4	Analyze the impact of propagation delay and timing constraints in digital systems and apply static timing analysis and testability concepts using case studies. **[Analyze]**
CO5	Create and evaluate innovative digital solutions by integrating combinational and sequential logic to address real-world design challenges. **[Create and Evaluate]**

CO - PO MAPPING

CO	PO1	PO2	PO 3	PO4	PO5	PO6	PO7	PO8	PO 9	PO10	PO11
CO 1	3	3									2
CO 2	3	3	3		3			2		2	2
CO 3	3	3	3		3			2		2	2
CO 4	3										2
CO5	3	3	3	2	3			2		2	2

Assessment Pattern for Theory Component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	√	√		√
Understand	√	√		√
Apply	√	√		√
Analyze		√	√	
Evaluate				
Create				

Assessment Pattern for Project Component

Bloom's Category	Continuous Assessment Tools		
	Evaluation 1	Evaluation 2	Report
Remember			
Understand			
Apply			
Analyze			
Evaluate		√	√
Create	√	√	

Mark Distribution of CIA

Att	Theory [L]	Project [R]	Total

en da nce	Assignm ent	Test-1	Test-2	Evaluati on-1	Evaluatic n-2	Report	Marks
5	5	7.5	7.5	10	10	5	**50**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	50	50	2 hrs.

End Semester Examination [ESE]: Pattern

PATT ERN	PART A	PART B	ESE Marks
PATT ERN 2	2 Questions from each module. Any full 6 Questions, each carrying 3 marks (6x3 =18 marks)	2 questions will be given from each module, of which 1 question should be answered. Each question can have a maximum of 3 subdivisions. Each question carries 8 marks. (4x8 = 32 marks)	50

SYLLABUS

MODULE I: Digital representation of information and Boolean algebra (9 hours)

Introduction to digital circuits: Review of number systems representation- conversions (Binary, Decimal, Hexadecimal, Octal) , Arithmetic of Binary number systems, Signed and unsigned numbers, BCD. **Boolean algebra:** Theorems, Sum of Products (SOP) and Product of Sums (POS) – simplification using algebraic methods, canonical forms – min term and max term representation, simplification of Boolean expressions – using algebraic method, Karnaugh map (up to 4 variables), implementation of Boolean expressions using universal gates (NAND and NOR).

Self-Study (18 hrs)

1. **Summary Table**: Compare number systems (binary, decimal, hex, octal), conversions, Boolean theorems, and SOP/POS forms with examples.
2. **IC Analysis & Simulation**: Study logic IC datasheets (e.g., 7408, 7486) for specs like propagation delay; simulate circuits (4-bit adder, K-map simplifications).
3. **Digital System Case Study**: Analyze components (counters, decoders) in systems like traffic lights or clocks, highlighting Boolean logic and BCD usage.
4. **Automotive Digital Circuits:** Highlight applications in cars (e.g., CAN bus for data communication, ABS using binary sensors, BCD in dashboards) and their reliance on digital logic.
5. **Lecture Summaries:** Recap video content on K-map simplification and universal

gate implementations, with diagrams for clarity.

MODULE II: Combinational logic circuits and Introduction to HDL (9 hours)

Combinational logic circuits: Design and analysis of basic building blocks – Half adders and Full adders, Subtractors, BCD adder, Ripple carry and Carry look-ahead adders. Implementation of Decoders, Encoders, Comparators, Parity generators, Multiplexers, and De-multiplexers with practical realization using logic gates and HDL-based descriptions. Boolean function implementation using multiplexers, with corresponding **HDL modeling of logic gates and combinational logic circuits** using basic language elements and structural or behavioral abstraction levels.

Self-Study (18 hrs):

1. **K-Map to Verilog Conversion**
   Given a 4-variable Boolean expression, simplify it using a K-map and write its equivalent Verilog code. Test it using simulation tools and record output waveforms.
2. **Data Sheet Study and Application**
   Study the datasheets of key combinational ICs such as:
   a. 4:1 multiplexer (e.g., 74LS153)
   b. Priority encoder (e.g., 74LS148)
   c. 4-bit comparator (e.g., 74LS85)
   Summarize their **pin configurations**, **truth tables**, and **typical usage scenarios** in digital systems.
3. **Research Project: HDL vs Traditional Logic Design**
   Prepare a short comparative report or presentation that includes:
   a. Differences between schematic-based and HDL-based digital circuit design
   b. Pros and cons of each approach in terms of scalability, speed of development, and debugging
4. **Digital System Case Study:** Analyze a traffic light controller or digital calculator, breaking down components like decoders (7-segment display), comparators (threshold checks), and adders.

MODULE III: Sequential Circuits and finite state machines(11 hours)

Sequential Circuits: Introduction to sequential circuits such as SR Latch, Flip-flops (SR, JK, Master-Slave JK, D, T) and modelling for flip-flop behaviour with HDL. Conversion of flip-flops with excitation tables and characteristic equations in HDL. Introduction to Finite State Machines (FSM). **Counters:** Construction of ring and Johnson counters, design of asynchronous, synchronous, and Mod N **counters** and modelling them using HDL. Introduction to Finite State Machine (**FSM**). **Shift registers:** Design and implementation of **shift registers** (SIPO, SISO, PISO, PIPO).

Self-Study (20 hrs)

1. **Foundations & Video Tutorials:** Learn core concepts from NPTEL/Video Tutorials covering FSMs (Mealy vs. Moore), flip-flops/latches, shift registers, and counters. Take notes, draw timing diagrams.
2. **Flip-Flop & Latch Mastery**: Simulate and compare SR latches and D flip-flops using Falstad/Tinkercad.
3. **Shift Registers & Counters Lab:** Design and simulate shift registers (SIPO, PISO), ring/Johnson counters, and Mod-N counters in HDL. Implement a 3-bit up/down counter and interface shift registers with SPI for practical applications.
4. **Troubleshooting & Optimization:** Debug faulty sequential circuits, resolve metastability. Asynchronous systems for power using LTspice. Document findings with waveforms and analysis reports.

MODULE IV: Timing Analysis, Fault Testing(7 hours)

Propagation Delay: Modeling delay in combinational and sequential circuits (gate delay, interconnect delay, clock skew). **Static Timing Analysis (STA):** STA overview, timing constraints (setup time, hold time, critical path, clock period). **Fault Testing:** Stuck-at faults, test vector generation, fault coverage, fault simulation.

Self-Study (16 hrs)

1. **Propagation Delay Visualization**
   Model and simulate the effect of gate delay and interconnect delay in a combinational circuit (e.g., 4-bit adder) using HDL with delay annotations. Analyze timing changes using waveform viewers.
2. **STA Case Study and Report**
   Explore an STA tool (e.g., Vivado, Quartus, or openSTA) and document how setup and hold time violations are detected. Create a report with timing diagrams and critical path analysis.
3. **Fault Detection Mini Project**
   Inject stuck-at-0 and stuck-at-1 faults into a simple combinational circuit in HDL. Generate and apply test vectors. Record fault coverage and simulate using testbenches.

Textbooks

1. **M. Morris Mano**, **Michael D. Ciletti**, *Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog*, 6th Edition, Pearson India, 2018.
2. **John F. Wakerly**, *Digital Design: Principles and Practices*, 5th Edition, Pearson, 2018.

Reference books

1. **Stephen Brown, Zvonko Vranesic**, *Fundamentals of Digital Logic with Verilog Design*, 4th Edition, McGraw Hill, 2020.

NPTEL/SWAYAM Courses for reference:

1. NPTEL : Digital Circuits and Systems : IIT Madras
   https://archive.nptel.ac.in/courses/117/106/117106086/

2. NPTEL : Switching Circuits and Logic Design : IIT Kharagpur https://archive.nptel.ac.in/courses/106/105/106105185/		
No.	**COURSE CONTENTS AND LECTURE SCHEDULE**	**No.of Hours [36 hours]**
MODULE 1 [9 hours]		
1.1	Introduction to digital circuits: Review of number systems representation- conversions (Binary, Decimal, Hexadecimal, Octal).	1
1.2	Arithmetic of Binary number systems, Signed and unsigned numbers, BCD.	1
1.3	Boolean algebra: Theorems, Sum of Products (SOP) and Product of Sums (POS) – simplification using algebraic methods, canonical forms – minterm and maxterm representation	2
1.4	Simplification of Boolean expressions – using algebraic method, Karnaugh map (up to 4 variables)	3
1.5	Implementation of Boolean expressions **using universal gates (NAND and NOR)**	2
MODULE II [9 hours]		
2.1	Half adder and Full adders, Subtractors, BCD adder, Ripple carry and carry look ahead adders and its implementation using HDL	3
2.2	Decoders, Encoders, Comparators, Parity generator and its implementation using HDL	2
2.3	Multiplexers, and De-multiplexers with practical realization using logic gates and HDL-based descriptions.	2
2.4	Boolean function implementation using multiplexers, with corresponding HDL modeling of logic gates and combinational logic circuits using basic language elements and structural or behavioral abstraction levels.	2
MODULE III [11 hours]		
3.1	Introduction to sequential circuits such as SR Latch, Flip-flops (SR, JK, Master-Slave JK, D, T) and modelling for flip-flop behaviour with HDL	2
3.2	Conversion of flip-flops with excitation tables and characteristic equations.	3
3.3	Construction of ring and Johnson counters, design of asynchronous, synchronous, and Mod N counters and modelling then using HDL.	3
3.4	Design and implementation of shift registers (SIPO, SISO, PISO, PIPO).	2
3.5	Introduction to Finite State Machine (**FSM**).	1
MODULE IV [7 hours]		
4.1	Modeling delay in combinational and sequential circuits (gate delay, interconnect delay, clock skew).	2
4.2	Static Timing Analysis (STA): STA overview, timing constraints (setup time, hold time, critical path, clock period)	3
4.3	Fault Testing: Stuck-at faults, test vector generation, fault coverage,	2

	fault simulation.	
	PROJECT	
Description: To immerse students in applying combinational logic circuit design principles through project-based assignments. Students will gain practical experience in designing and simulating logic circuits, analyzing Boolean functions, modeling digital components using HDL, and optimizing circuit performance. Emphasis will be placed on integrating theoretical concepts with real-world digital system applications such as arithmetic units, data selectors, and control logic in embedded systems.		
LESSON PLAN FOR PROJECT COMPONENT		
No. Topic	**Topic**	**No. of Hours (12)**
1	Preliminary Design of the Project	2
2	Zeroth presentation (4th week)	2
3	Project work - First Phase	2
4	Interim Presentation	2
5	Project work - Final Phase & Report writing (discussions in class during project hours)	2
6	Final Evaluation, Presentation and Exhibition (11th and 12th weeks)	2

CO Assessment Questions

CO-1

1. Given the decimal number 156, convert it into its binary and hexadecimal equivalents.
2. Simplify the following Boolean expression using Boolean algebra and the Karnaugh map method: (A'B + AB')C + AC).
3. You are given a signed 8-bit binary number 11101101. Convert it to its decimal equivalent.
4. For a 4-variable Boolean expression, derive its canonical sum-of-products (SOP) form from the truth table provided below.

A	B	C	Output (F)
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	1

5. Using the rules of BCD (Binary-Coded Decimal), convert the decimal number 59 to its BCD representation.

CO-2	1. Explain how the binary addition of two 4-bit numbers is performed. Provide an example with the numbers 1101 and 1011, and show the step-by-step process of adding these numbers. 2. Given the Boolean expression (A+B)(C+D)(A + B)(C + D)(A+B)(C+D), expand it using the distributive property of Boolean algebra, and then simplify the resulting expression using Boolean theorems. 3. Derive the truth table for a Full Adder circuit. 4. What is the difference between a combinational and sequential logic circuit? Illustrate this difference by explaining the operation of a Half Adder (combinational) and a JK Flip Flop (sequential). 5. Using the Karnaugh map method, simplify the following Boolean expression: A′BC+AB′C′+ABCA'BC + AB'C' + ABCA′BC+AB′C′+ABC.
CO-3	1. Given a JK Flip Flop with the following inputs (J=1, K=0) and an initial state of Q = 0, determine the next state after the clock pulse. Explain the operation of the JK flip flop and the role of the clock signal in determining the state change. 2. Design a 3-bit synchronous counter using D flip-flops. Create the state diagram, state table, and excitation table for the counter. Then, explain the process of converting the state diagram into the counter design. 3. You are given a Johnson counter circuit with four flip-flops. Draw the circuit diagram and derive the sequence of outputs generated by the counter. Explain how the outputs are related to the clock pulses and how this differs from a ring counter.
CO-4	1. Differentiate between setup time and hold time with suitable timing diagrams. 2. What is the critical path in a digital circuit and why is it important in timing analysis? 3. Given a digital circuit netlist, identify the longest path and calculate the propagation delay assuming standard gate delays. 4. Create a testbench in Verilog to validate stuck-at-0 faults in a 2-to-1 multiplexer. 5. A design fails timing closure during STA. Identify three possible causes and propose corresponding solutions.
	1. Traffic Light Controller with Pedestrian Mode : Design a digital system that manages traffic signals for a four-way intersection including pedestrian control using FSM and timing logic. 2. Digital Vending Machine Controller: Create a logic circuit that accepts coin inputs, determines item availability, and dispenses products with change calculation. 3. Elevator Controller System: Design a controller for a multi-floor elevator that manages up/down movement, door control, and floor selection using sequential logic.

CO-5	4. Automatic Washing Machine Cycle Controller: Develop a digital control unit to automate washing cycles (wash, rinse, spin, dry) using a state machine model. 5. Electronic Voting Machine (EVM):Design a simple voting machine logic that can register votes, count them, and declare a winner from multiple candidates. 6. Parking Lot Management System: Build a digital circuit that detects vehicle entry/exit, counts cars, and controls a display showing available spaces. 7. Digital Lock System with Password Verification: Design a secure digital lock using keypad input, password validation, and alarm triggering for wrong attempts. 8. Temperature-Based Fan Control System (using digital logic): Model a system where fan speed is controlled based on temperature range inputs using digital comparators and counters. 9. Quiz Buzzer System for Multiple Players: Create a logic system that detects the first player to press a buzzer and locks out all other inputs. 10. Real-Time Clock Using Digital Logic: Design a clock showing seconds, minutes, and hours using counters, decoders, and multiplexed display logic.

Content Beyond Syllabus

RTL Design Flow and RTL Coding Guidelines

- **Topics**:
  - Clean RTL coding for synthesis (FSM encoding, clock gating, reset types).
  - Writing synthesizable Verilog (avoid latches, blocking vs non-blocking).
- **Tools**: Cadence Genus Synthesis Solution
- **Value Addition**: Prepares students for industry RTL coding and synthesis tools.

2. ASIC Design Flow Overview

- **Topics**:
  - ASIC design flow stages: Specification → RTL → Synthesis → Place & Route → GDSII.
  - Role of EDA tools at each stage.
- **Tools**: Genus, Innovus, Conformal (Cadence tools)
- **Mapped COs**: Extends CO5 to full ASIC-level digital design.

Prepared by
Ms. Vidyamol K,
Department of ECE

24HUT005	ENGINEERING ECONOMICS	L	T	P	R	C	Year of Introduction
		2	0	0	0	2	2024

Preamble: To provide students with fundamental concepts of economics related to engineering industry, understanding of how price and output determined in different markets, macroeconomic concepts and to deliver the basic concepts of value engineering.

Prerequisite: None

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

CO 1	To learn the basic economic concepts and to understand the fundamentals of various economic issues. **[Understand]**
CO 2	To acquire knowledge regarding the functioning of firms in different market situations and to develop decision making capability by applying concepts relating to cost and revenue. **[Apply]**
CO 3	To demarcate the macroeconomic principles of monetary and fiscal systems , national income and stock market. **[Understand]**
CO 4	To solve simple business problems using break -even analysis, capital budgeting techniques, and bring to bear the possibilities of value analysis and value engineering. **[Analyze]**

CO - PO MAPPING											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO 1		2			2	2		2		3	3
CO 2		2			2	2		2		3	3
CO 3		2			2	2		2		3	3
CO 4		2			2	2		2		3	3

Assessment Pattern for Theory Component

Bloom's Category	**Continuous Assessment Tools**			**End Semester Examination**
	Test1	**Test 2**	**Other tools**	
Remember	√	√	√	√
Understand	√	√	√	√
Apply	√	√	√	√
Analyze	√	√	√	√
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-R]	**Theory [L]**					**Total Marks**
	Attendance	**Assignment**	**Test 1**	**Test 2**	**Case study**	
2-0-0-0	5	5	10	10	20	**50**

Total Marks distribution

Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	50	50	2 hrs.

End Semester Examination [ESE]: Pattern

PATTERN	**PART A**	**PART B**	**ESE Marks**
PATTERN 2	2 Questions from each module. Any full 6 Questions, each carrying 3 marks (6x3 =18 marks)	2 questions will be given from each module, of which 1 question should be answered. Each question can have a maximum of 3 subdivisions. Each question carries 8 marks. (4x8 = 32 marks)	50

MODULE I: DEMAND AND SUPPLY ANALYSIS (7 hours)

Basic Economic Concepts- Central problems of an economy -Production Possibility Curve-Utility-Law of diminishing marginal utility-Law of equi marginal utility- Law of Demand and Supply-Elasticity of Demand-Measurement of elasticity and its applications-Market Equilibrium-Changes in demand and Supply- its effects-Consumer surplus and producer surplus-Production functions in the short and Long run-Economies of scale-Internal and External economies-Cobb-Douglas Production Function. Taxation-Direct and indirect tax-Value Added Tax -Goods and Service Tax-Deadweight Loss. Case study on discounts for products in E-commerce.

Self-Study:(8 Hours)

1. Read and summarise what is economy and economics.
2. Read and make note on how does a consumers utility change when their income increases? Explain with the help of normal and inferior goods?
3. Explain the factors affecting the market demand of a commodity?
4. Study and make report on Impact of GST on small business in your city**.**

MODULE II: MARKET STRUCTURE (7 hours)

Costs Concepts- Social cost ,Private cost-Explicit and Implicit cost-Sunk cost- Opportunity cost-Short run and long run cost curves-Revenue concepts- shut down point-Markets-Perfect competition- Monopoly-Monopolistic Competition-Oligopoly (price and output determination)-Non- price competition-Product pricing-Methods of product pricing. Case study on Monopolistic competition (Industry consumer electronics).

Self Study:(8 Hours)

1. Explain cost estimation techniques for engineering projects?
2. Read and summarise fixed and variable cost?
3. With real life example explain opportunity cost?
4. Explain the importance and methods of product pricing?

MODULE III: MACRO ECONOMIC CONCEPTS (7 hours)

National income -Concepts-Methods of estimating National income -Circular flow of income in two and four sector economy-Business financing -Bonds and shares- Financial Market-Stock market -Functions-Problems faced by the Indian stock market-Demat Account and Trading Account-Stock market indicators-SENSEX And NIFTY. Meaning and functions of Money-Central Banking-Inflation-Causes and effects -Measures to control inflation- Monetary and fiscal policies-Deflation-Case study on ”Impact of rising food prices on middle income house holds in your city”.

Self Study: (8 Hours)

1. Read and Summarise how the national income of India is calculated?
2. Explain the causes of inflation?
3. Study and make report on :“A New Investor's Journey in Stock Market Trading"
4. Explain the impact of deflation in an economy?

MODULE IV:VALUE ANALYSIS AND VALUE ENGINEERING (7 hours)

Value Analysis and Value Engineering-Cost value, -Exchange value, -Use value-, Esteem value-Aims, Advantages and Application areas of value engineering-Value Engineering Procedure-Break-even-Analysis -Capital Budgeting-Time value of money-Net Present Value Method-Benefit Cost Ratio-Internal Rate of Return-Payback-Accounting Rate of Return-Decision tree analysis-Profit and balance sheet analysis-Game theory application in engineering. Case study on Value addition in food processing industry.

Self -study:(8 Hours)

1. Explain the Time value of money in project evaluation?
2. Read and summarise the importance of cost benefit analysis?
3. Explain engineering decision- making under uncertainity?
4. Study and make report on" The rise of Gig economy and its impact on engineers".
5. Explain Nash equilibrium?

Textbooks

1. Managerial Economics- Geetika, Piyali Gosh and Choudry-Tata McGrawHill-2015.
2. Engineering Economy- H.G.Thuesen, W.JFabrycky-PHI-1966.
3. Engineering Economics -R.Paneerselvam-PHI-2012

Reference books

1. Leland Blank. P.E,Anthony Tarquin P.E-,Engineering Economy– *Mc Graw Hill* – 7th Edition.
2. Khan.M.Y-,Indian Financial System– Tata Mc Graw Hill –2011
3. Donald .G.Newman,Jerome.p.Lavelle-Engineering Economics And Analysis-Engineering pressTexas-2002
4. Chan.S.Park-Contemporary Engineering Economics-Prentice Hall of India Ltd-2001

NPTEL/SWAYAM Courses for reference:

1. NPTEL: Principles of Economics, Prof.Sabuj Kumar Mandal [IIT Madras] https://onlinecourses.nptel.ac.in/noc23_ec06/preview
2. NPTEL:Enginering Economic Analysis ,Dr.Pradeep Kumar Jha[IIT Roorkee] https://onlinecourses.nptel.ac.in/noc23_ec03/preview

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours (28 hours)
	MODULE I (7 hours)	
1.1	Basic Economic Concepts-Central Problems of an economy-Production possibility curve-Utility -Law of Diminishing Marginal Utility-Law of equi -marginal utility.	2
1.2	Law of Demand and Supply-Elasticity of Demand-Measurement of Elasticity and its applications.	1
1.3	Market Equilibrium - Changes in demand and supply-its effects-Consumer Surplus and Producer Surplus.	2
1.4	Production function in the Short and long run.	1

1.5	Economies of Scale-Internal and external economies-Cobb - Douglas production function. Taxation-Deadweight Loss	1
MODULE II (7 hours)		
2.1	Cost Concepts- Social cost -Private cost -Explicit and implicit cost-Sunk cost- Opportunity cost.	1
2.2	Short run and Long run cost Curves-Revenue Concepts. -Shut down point.	1
2.3	Markets-Perfect competition – Monopoly.	2
2.4	Monopolistic competition – Oligopoly.	2
2.5	Non-price Competition - Product pricing- Methods of Product Pricing.	1
MODULE: III (7 hours)		
3.1	National Income-Concepts-Methods of estimating national income.	2
3.2	Circular flow of income in two and four sector economy.	1
3.3	Business Financing-Bonds and Shares.	1
3.4	Financial market-Money market and Capital market.	1
3.5	Stock Market-Functions-Problems faced by the Indian Stock Market	1
3.6	Meaning and functions of money, Inflation and Deflation.	1
MODULE IV (7 hours)		
4.1	Value analysis and value engineering-Cost value-Exchange value-Use value-Esteem value-Aims, Advantages and its Application-Areas of Value Engineering.	1
4.2	Value Engineering Procedure.	1
4.3	Break- even- analysis.	1
4.4	Capital Budgeting-Time value of money-Net Present Value Method- Benefit Cost Ratio-Internal Rate of Return-Payback-Accounting Rate of Return.	2
4.5	Decision tree analysis-Profit and balance sheet analysis-Game theory application in engineering.	2
CO Assessment Questions		
CO1	1.Examine why the problem of choice arise? (Apply) 2.Explain central economic problems? (Analyze) 3.Outline how do we solve the basic economic problems? (Apply) 4.Interpret the relation between price and demand? (Apply)	

CO2	1.Explain shut down point? (Analyze) 2.Explain why monopolist called a price taker? (Analyze) 3Examine the equilibrium of a firm under monopolistic competition? (Apply) 4.Outline the methods of product pricing? (Apply)
CO3	1.Explain the methods of estimating national income? (Analyze) 2.Distinguih between bonds and shares? (Analyze) 3.Examine the functions of money? (Apply) 4.Outline problems faced by Indian stock market? (Apply)
CO4	1. Explain break even analysis? (Analyze) 2. Examine capital budgeting methods? Apply) 3.Distinguish between exchange value and use-value? (Analyze) 4.Digramatically explain decision tree analysis? (Analyze)

Prepared by,
Ms. Vini Valsan, Asst. Prof. ASH

24EST306	**APPLIED DATA SCIENCE & ARTIFICIAL INTELLIGENCE**	**L**	**T**	**P**	**R**	**C**	**Year of Introduction**
		3	1	0	0	4	**2024**

Preamble: This course covers the fundamentals of data analysis, including essential concepts in statistics and linear algebra, which form the basis for working with real-world data. Students will learn how to clean, transform, and visualize data, as well as handle missing values and detect outliers. The course provides hands-on experience with Python programming and data science libraries such as Pandas, NumPy, and Matplotlib. Additionally, it introduces the basics of machine learning and explores how these techniques are applied in engineering and industrial contexts..

Prerequisite: Problem Solving and Algorithmic Thinking with Python(24ESR105)

Course Outcomes: After the completion of the course the student will be able to

CO1	Understand and apply basic probability and statistical methods to describe and analyze data distributions. [**Apply**]
CO2	Perform vector and matrix operations and utilize linear algebra concepts essential for data science and machine learning applications [**Apply**].
CO3	Carry out exploratory data analysis (EDA), including data collection, cleaning, visualization, and statistical summarization [**Apply**].
CO4	Demonstrate foundational knowledge of machine learning paradigms and apply selected algorithms for classification and regression problems using Python [**Analyze**].

CO - PO MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**

CO 1	3	3	3	3	2						
CO 2	3	3	3	3	3						2
CO 3	2	3	3	3	3				2		
CO 4	3	3	2	3	3			2			2

Assessment Pattern for Theory Component

Bloom's Category	**Continuous Assessment Tools**			**End Semester Examination**
	Test1	**Test 2**	**Other tools**	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse		✓	✓	✓
Evaluate		✓	✓	✓
Create				

Assessment Pattern for the Lab component

Bloom's Category	**Continuous Assessment Tools**	
	Class work	**Test1**
Remember	✓	✓
Understand	✓	✓
Apply	✓	✓
Analyze		
Evaluate		
Create		

Mark Distribution of CIA

Course Structure [L-T-P-R]	**Attendance**	**Assignment**	**Theory [L- T]**		**Total Marks**
			Test-1	**Test-2**	
3-1-0-0	5	10	12.5	12.5	40

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	2.5 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	8 Questions, each question carries 3 marks Marks: (3x8 =24 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 9 marks. Marks: (9x4 = 36 marks)	60

SYLLABUS

MODULE I: Probability and Statistics Foundations (11 hours)

Introduction to probability: sample space, events. Conditional probability, Bayes' theorem. Independent and dependent events. Random variables: discrete and continuous. Population and sample, population mean, sample mean. Measures of central tendency: mean, median, mode. Measures of dispersion: range, variance, standard deviation. Covariance and correlation: interpretation and calculation.

Tutorial Questions:

- Problems on Probability
- Random variables
- Measures of Dispersion
- Covariance and Correlation

Self Study:(16 Hours)

1. Difference Between Classical and Empirical Probability
2. Understanding Conditional Probability with Real-Life Applications
3. Bayes' Theorem and Its Applications in Decision Making
4. Compare Covariance and Correlation.

MODULE II: Linear Algebra for Data Science (11 hours)

Introduction to vectors: properties, vector addition and subtraction, scalar multiplication. Vector norms and distance metrics. Matrix concepts: types of matrices, matrix addition and multiplication, transpose, inverse, determinant, trace. Dot product and matrix

multiplication. Eigenvalues and eigenvectors: interpretation and computation. Singular Value Decomposition (SVD): concept and applications. Introduction to linear transformations.

Tutorial Questions:

- Vector addition, subtraction, and scalar multiplication
- Concepts of eigenvalues and eigenvectors
- SVD

Self Study:(20 Hours)

1. Orthogonality and Orthogonal Vectors
2. Matrix Rank and Its Significance
3. LU Decomposition and Solving Linear Systems
4. Principal Component Analysis (PCA) using Eigenvectors
5. Vector and Matrix Broadcasting in NumPy.

MODULE III: Exploratory Data Analysis (EDA) (14 hours)

Introduction to data analysis and the EDA process. Types of data: structured, unstructured, categorical, numerical. Data collection techniques and sources (CSV files, APIs, databases). Data cleaning: fixing rows and columns, handling missing data, standardizing values, treating invalid entries, removing duplicates. Univariate analysis: distribution of individual variables. Bivariate analysis: relationships between two variables. Data visualization: histograms, boxplots, scatterplots, pair plots, heatmaps.

Tutorial Questions:

- Data Cleaning
- Bivariate Analysis
- Boxplots

Self Study:(18 hours)

1. Feature engineering techniques
2. Outlier detection and treatment methods
3. Advanced data visualization with Plotly and Bokeh
4. Time series data analysis basics, Introduction to big data tools for EDA (e.g., Apache Spark)
5. Introduction to clustering for exploratory analysis
6. Data quality assessment metrics and frameworks

MODULE IV: Machine Learning and Python for Data Science (12 hours)

Python data structures: lists, tuples, sets, dictionaries. Introduction to libraries: NumPy for numerical operations, Pandas for data manipulation, Matplotlib for visualization, SciPy for scientific computation. Introduction to machine learning: overview of supervised, unsupervised, and reinforcement learning. Key algorithms: regression, classification (logistic, Naïve Bayes), clustering (K-means). Model training and testing using scikit-learn. Evaluation metrics: accuracy, precision, recall, F1 score, confusion matrix. End-to-end implementation of a basic machine learning pipeline with real-world datasets.

Tutorial Questions:

1. K-Nearest Neighbors (KNN) algorithm.
2. Classification Examples
3. Data Structure Applications

Self Study:(18 Hours)

1. Ensemble learning basics (Random Forest, Gradient Boosting)
2. Basics of neural networks and deep learning frameworks (TensorFlow, PyTorch)
3. Introduction to unsupervised learning beyond K-means (DBSCAN, hierarchical clustering)
4. Project Title: "Customer Segmentation and Purchase Prediction using Machine Learning".

Textbooks

1. Python Data Science Handbook. Essential Tools for Working with Data, Author(s): Jake VanderPlas, Publisher: O'Reilly Media, Year: 2016
2. Practical Statistics for Data Scientists: 50 Essential Concepts, Author(s): Peter Bruce, Andrew Bruce, Publisher: O'Reilly Media, Year: 2017

Reference books

1. Practical Linear Algebra for Data Science, by Mike X Cohen, Released September 2022, Publisher(s): O'Reilly Media, Inc.
2. Data Science from Scratch 'by Joel Grus, Released, April 2015, Publisher(s): O'Reilly Media, Inc.
3. Hands-On Exploratory Data Analysis with Python, by Suresh Kumar Mukhiya, Usman Ahmed, Released March 2020,Publisher(s): Packt Publishing

NPTEL/SWAYAM Courses for reference:

1. Data Science for Engineers : https://onlinecourses.nptel.ac.in/noc25_cs101/preview
2. Artificial Intelligence and Machine Learning in Materials Engineering : https://onlinecourses.nptel.ac.in/noc25_mm37/preview

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours [48 hours]
MODULE 1 [11 hours]		
1.1	Basic concepts of probability, sample space, events	1
1.2	Conditional probability, total probability, independent events	2
1.3	Bayes' theorem and its applications	2
1.4	Random variables: discrete and continuous	1
1.5	Population, sample, population/sample mean	1
1.6	Measures of central tendency: mean, median, mode	1
1.7	Measures of dispersion: range, variance, standard deviation	2
1.8	Covariance and correlation	1
MODULE II [11 hours]		
2.1	Introduction to vectors and operations (addition, scalar multiplication)	1
2.2	Vector norms and distance between vectors	1
2.3	Introduction to matrices and basic operations	1
2.4	Matrix properties: transpose, inverse, determinant, trace	1
2.5	Dot product and matrix multiplication	1
2.6	Eigenvalues and eigenvectors	2
2.7	Singular Value Decomposition (SVD)	2
2.8	Linear transformations and applications	1
2.9	Practical session with NumPy	1
MODULE III [14 hours]		
3.1	Introduction to EDA and types of data	1
3.2	Data collection methods and sources (APIs, CSV, databases)	1
3.3	Data cleaning: fixing rows/columns, handling missing/invalid values	2
3.4	Univariate analysis: categorical and numerical variables	2
3.5	Bivariate analysis and correlation analysis	2

3.6	Descriptive statistics: mean, median, mode, variance	1
3.7	Data visualization: histograms, boxplots, scatterplots	2
3.8	Data transformation and filtering	2
3.9	Hands-on with Pandas and Seaborn	1
MODULE IV [12 hours]		
4.1	Python data structures: list, tuple, set, dictionary	1
4.2	Introduction to libraries: NumPy, Pandas, Matplotlib, Seaborn	2
4.3	Introduction to machine learning: supervised, unsupervised, RL	1
4.4	IRegression and classification: concepts and use cases	2
4.5	Naïve Bayes and K-Nearest Neighbors	2
4.6	MIntroduction to clustering and K-means	1
4.7	Model evaluation: accuracy, confusion matrix, precision, recall	1
4.8	End-to-end ML pipeline with Scikit-learn	2

CO Assessment Questions

CO 1	1. Define conditional probability and solve a problem involving Bayes' Theorem using real-world data.(6 marks) 2. A dataset contains exam scores of 100 students. Calculate the mean, median, mode, variance, and standard deviation. Interpret your results.(6 marks) 3. Compare and contrast population and sample distributions. Provide examples where sampling distribution plays a critical role(5 marks)
CO 2	1. Given two vectors, compute their dot product, norm, and the distance between them.(5 marks) 2. For a given 3×3 matrix, calculate its determinant, inverse, and eigenvalues using NumPy(6 marks). 3. Explain the role of Singular Value Decomposition (SVD) in dimensionality reduction and demonstrate with a sample dataset.(6 marks)
CO 3	1. Collect a small dataset from a public source (e.g., Kaggle or UCI), identify missing values, and demonstrate how to handle them using Pandas.(5 marks) 2. Perform univariate and bivariate analysis on a dataset. Include visualizations (boxplots, histograms, scatterplots) and interpret the

	patterns.(6 marks) 3. Discuss the role of outlier detection in data cleaning. Use a boxplot to identify outliers in a numeric feature and explain your treatment method.(5 marks)
CO 4	1. Write Python code to read a CSV file, display summary statistics, and plot a histogram using Pandas and Matplotlib.(6 marks) 2. Using NumPy, create two matrices and perform operations: addition, multiplication, transpose, and trace.(6 marks) 3. Use Seaborn to create a heatmap showing correlation between features in a dataset. Interpret the visual result. (6 marks).

Assignment Questions

1. You have a dataset of house prices (Price) based on Area_sqft and NumberOfBedrooms. You want to build a linear regression model using scikit-learn.

   (a) Outline the steps involved in preparing this data for a scikit-learn LinearRegression model, including splitting the data into training and testing sets. Write conceptual Python code using train_test_split and model instantiation.

   (b) After training your LinearRegression model, you need to evaluate its performance on the test set. Beyond just fitting the model, describe how you would use scikit-learn to make predictions on the test set and calculate a common regression evaluation metric like Mean Squared Error (MSE). Show the relevant scikit-learn function calls.

   (c) Briefly explain why it is crucial to evaluate your model on a separate "test set" rather than the "training set."

2. You are provided with a Pandas DataFrame df_sales representing sales transactions with the following columns: OrderID, ProductID, Quantity, UnitPrice, SaleDate, Region.

   (a) Write Pandas code to perform the following two operations: * Calculate a new column TotalPrice (Quantity * UnitPrice). * Filter the DataFrame to include only sales from the 'East' region and SaleDate after '2023-01-01'.

   (b) Describe how you would use Pandas to group the filtered data by ProductID and calculate the total TotalPrice for each product, as well as the average Quantity sold per product. Show the Pandas method calls you would use.

   (c) You notice that some UnitPrice values are recorded as 0. Explain how you would identify rows where UnitPrice is 0 and then propose a strategy to handle these invalid entries (e.g., remove rows, impute values) in a production environment,

justifying your choice.

Prepared By

Dr. Sreeraj R
Professor, CSE

Dr. Krishnadas J
Associate Professor, CSE

Dr. Asha S
Associate Professor, CSE

							Introduction
		0	**0**	**3**	**0**	**2**	**2024**

Preamble: The Analog Circuits Laboratory is designed to provide students with practical exposure to the fundamental principles of analog electronics. This course bridges theoretical concepts with hands-on experimentation, focusing on the design, analysis, and testing of analog components and systems. Students will gain proficiency in using electronic instruments, constructing and troubleshooting circuits, and interpreting experimental data.

Prerequisite: 24EST023 : Fundamentals of Electrical & Electronics Engineering
24ESL006 - Basic Electrical and Electronics Engineering Workshop

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

CO1	Familiarize the basic signal generators and display devices. **[Understanding]**.
CO2	Construct and demonstrate the functionality of basic analog circuits using discrete components.**[Apply]**
CO3	Construct and simulate the functioning of basic analog circuits using simulation tools. **[Apply]**
CO4	Analyze the frequency response of amplifiers **[Analyze]**

CO - PO MAPPING

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

Assessment Pattern

Bloom's Category	**Continuous Assessment Tools**	
	Classwork	**Test**
Remember		
Understand	√	√
Apply	√	√
Analyze	√	
Evaluate	√	
Create	√	

Mark Distribution of CIA

Course Structure [L-T-P-R]	**Attendance**	**Classwork**	**Lab Exam**	**Total Marks**
0-0-3-0	5	25	20	50

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	50	50	2 hours

End Semester Examination Pattern:

The following guidelines should be followed regarding award of marks

(a) Procedure/Preliminary Work/Design/Algorithm (10 Marks)

(b) Conduct of Experiment/Execution of Work/Programming (15 Marks)

(c) Result with Valid Inference/Quality of Output (10 Marks)

(d) Viva Voce (10 Marks)

(e) Record (5 Marks)

SYLLABUS- DETAILS OF EXPERIMENTS

Part A : List of Experiments using discrete components [Any Six experiments mandatory]

1. RC integrating and differentiating circuits (Transient analysis with different inputs and frequency response)
2. Clipping and clamping circuits (Transients and transfer characteristics)
3. RC coupled CE amplifier - frequency response characteristics
4. MOSFET amplifier (CS) - frequency response characteristics
5. Cascade amplifier – gain and frequency response
6. Cascode amplifier -frequency response
7. Feedback amplifiers (current series, voltage series) - gain and frequency response
8. Low frequency oscillators –RC phase shift or Wien bridge
9. Power amplifiers (transformer less) - Class B and Class AB
10. Transistor series voltage regulator (load and line regulation)

PART B Simulation experiments [Any Six experiments mandatory]
The experiments shall be conducted using open tools such as QUCS, KiCad or variants of SPICE.

1. RC integrating and differentiating circuits (Transient analysis with different inputs and frequency response)
2. Clipping and clamping circuits (Transients and transfer characteristics)
3. RC coupled CE amplifier - frequency response characteristics
4. MOSFET amplifier (CS) - frequency response characteristics
5. Cascade amplifier – gain and frequency response
6. Cascode amplifier – frequency response
7. Feedback amplifiers (current series, voltage series) - gain and frequency response
8. Low frequency oscillators – RC phase shift or Wien bridge
9. Power amplifiers (transformer less) - Class B and Class AB
10. Transistor series voltage regulator (load and line regulation)

Note: *A minimum of 12 experiments are to be completed.*

Self-Study: 24 hrs

1. Refamiliarize yourself with breadboard connections and the basic working and safety precautions of common lab equipment such as the CRO, function generator, and DC power supply.
2. Study the different types of resistors and capacitors commonly used in electronic circuits and how to identify resistor values using color coding.
3. Study the conditions under which an RC circuit functions as an integrator or a differentiator.
4. Investigate Crossover Distortion in Class B and Class AB Amplifiers.
5. Study the conditions for oscillation using the Barkhausen criterion.

Textbooks

1. Electronic Devices and Circuits David A Bell Oxford University Press, 2008 5th edition
2. S. Sedra & K C Smith, Microelectronic Circuits, 7th Edition, Oxford University Press.2015.
3. Electronic Circuits Analysis and Design 1 D. Meganathan Yes Dee Publishing, 2023 1 st edition

Reference books

1. A. Neamen, Electronic Circuit Analysis and Design, 3rd Edition, McGraw-Hill India, 2006

CO Assessment Questions

CO1	1. Explain the importance of calibration in signal generators and display devices. 2. Explain the working principle of a function generator. 3. Describe the types and applications of CRO (Cathode Ray Oscilloscope) in electronic measurements. 4. Differentiate between analog and digital display devices with suitable examples.
CO2	1. Design and build a common-emitter amplifier using BJT and explain its working. 2. Build a Zener diode voltage regulator circuit and demonstrate its regulation capability. 3. Assemble a transistor switch circuit and demonstrate its use in controlling a load.
CO3	1. Simulate an RC low-pass filter circuit and analyze the output waveform for a sinusoidal input. 2. Design and simulate a voltage divider biasing circuit for a BJT and interpret the simulation results.

CO4	1. To design a small signal voltage amplifier and plot its frequency response to obtain bandwidth. 2. Compare the frequency responses of RC-coupled and transformer-coupled amplifiers. 3. Determine the -3dB points from a given frequency response plot of an amplifier circuit. 4. Analyze the effect of coupling and bypass capacitors on the frequency response of an amplifier.

Prepared by,
Ms.Siji Joseph
Asst. Prof,ECE Department,SCET

EDUCATION IS DEDICATION

24ECL308	**LOGIC CIRCUIT DESIGN LAB**	**L**	**T**	**P**	**R**	**C**	**Year of Introduction**
		0	**0**	**3**	**0**	**2**	**2024**

Preamble: The Logic Circuit Design Lab is a foundational course aimed at providing students with practical knowledge and hands-on experience in the design, analysis, and implementation of digital logic circuits. This lab emphasizes the understanding of

Boolean algebra, logic gates, and the construction of complex digital systems. Students will gain the skills to work with combinational and sequential circuits, using both basic components and more advanced tools.

Prerequisite:
Fundamentals of Electronics or Electrical Engineering Principles (FEEE 24EST023)

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

CO1	Apply the principles and functionality of various combinational circuits.**[Apply]**
CO2	Apply the principles and functionality of various sequential circuits.**[Apply]**
CO3	Analyze the design and behavior of digital circuits for implementation on FPGA boards. **[Analyze]**
CO4	Implement digital circuits using Verilog. **[Apply]**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11
CO1	3	2	2	2					3		2
CO2	3	2	2	2					3		2
CO3	3	2	2	2	3				3	2	2
CO4	3	2	2	2	3				3	2	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tools	
	Classwork	Test
Remember		
Understand	√	√
Apply	√	√
Analyze	√	
Evaluate		
Create		

Mark Distribution of CIA

Attendance	Classwork *(Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record)*	Internal Lab Exam	Total Marks
5	25	20	50

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	50	50	2 hours

End Semester Examination Pattern:

The following guidelines should be followed regarding award of marks
(a) Procedure/Preliminary Work/Design/Algorithm (10 Marks)
(b) Conduct of Experiment/Execution of Work/Programming (15 Marks)
(c) Result with Valid Inference/Quality of Output (10 Marks)
(d) Viva Voce (10 Marks)
(e) Record (5 Marks)

SYLLABUS- DETAILS OF EXPERIMENTS

PART A (ANY 5)

1. Realization of functions using basic and universal gates (SOP and POS forms).
2. Design and Realization of half /full adder and subtractor using basic gates and universal gates.
3. 4 bit adder/subtractor and BCD adder using 7483.
4. Study of Flip Flops: S-R, D, T, JK and Master Slave JK FF using NAND gates.
5. Asynchronous Counter:3 bit up/down counter.
6. Asynchronous Counter:Realization of Mod N counter.
7. Synchronous Counter: Realization of 4-bit up/down counter.
8. Synchronous Counter: Realization of Mod-N counters.
9. Ring counter and Johnson Counter. (using FF & 7495)
10. Realization of counters using IC's (7490, 7492, 7493).
11. Multiplexers and De-multiplexers using gates and ICs. (74150, 74154).
12. Realization of combinational circuits using MUX & DEMUX.
13. Random Sequence generator using LFSR

Self study: 12 Hrs

1. Review Boolean expressions, SOP/POS forms, and basic logic gates; understand universal gates.
2. Study logic equations and truth tables; simulate half/full adders and subtractors.
3. Revisit binary arithmetic and BCD concepts; study and simulate relevant ICs.
4. Learn types of flip-flops, timing diagrams, and simulate sequential circuits.
5. Understand ripple and Mod-N counters, reset logic, and observe timing behavior.
6. Explore synchronous counter design, state diagrams, and simulate using tools.
7. Study shift register operations and basic LFSR concepts with simulations.
8. Review MUX/DEMUX functionality and implement logic functions using MUXes.

PART B (ANY 5)

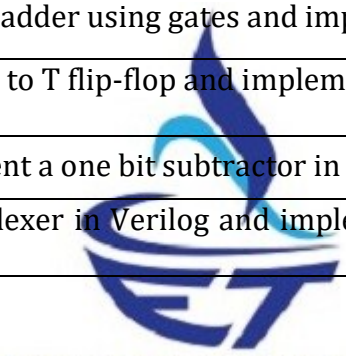
1. Realization of Logic Gates and Familiarization of FPGAs
(a) Familiarization of a small FPGA bboard and its ports and interface.
(b) Create the .pcf files for your FPGA board.
(c) Familiarization of the basic syntax of verilog
(d) Development of verilog modules for basic gates, synthesis and implementation in the above FPGA to verify the truth tables.
(e) Verify the universality and non associativity of NAND and NOR gates by uploading the corresponding verilog files to the FPGA boards.

2. Adders in Verilog

(a) Development of verilog modules for half adder in 3 modeling styles (dataflow/structural/behavioural). (b) Development of verilog modules for full adder in structural modeling using half adder.
3. Mux and Demux in Verilog (a) Development of verilog modules for a 4x1 MUX. (b) Development of verilog modules for a 1x4 DEMUX.
4. Flipflops and counters (a) Development of verilog modules for SR, JK and D flipflops. (b) Development of verilog modules for a binary decade/Johnson/Ring counters.
5. Multiplexer and Logic Implementation in FPGA (a) Make a gate level design of an 8 : 1 multiplexer, write to FPGA and test its functionality. (b) Use the above module to realize the logic function f (A, B, C) = ∑m(0, 1, 3, 7) and test it. (c) Use the same 8 : 1 multiplexer to realize the logic function f (A, B, C, D) = ∑m(0, 1, 3, 7,10, 12) by partitioning the truth table properly and test it.
6. Flip-Flops and their Conversion in FPGA (a) Make gate level designs of J-K, J-K master-slave, T and D flip-flops, implement and test them on the FPGA board. (b) Implement and test the conversions such as T to D, D to T, J-K to T and J-K to D.
7. Asynchronous and Synchronous Counters in FPGA (a) Make a design of a 4-bit up down ripple counter using T-flip-lops in the previous experiment, implement and test them on the FPGA board. (b) Make a design of a 4-bit up down synchronous counter using T-flip-lops in the previous experiment, implement and test them on the FPGA board.
8. Universal Shift Register in FPGA (a) Make a design of a 4-bit universal shift register using D-flip-flops in the previous experiment, implement and test them on the FPGA board. (b) Implement ring and Johnson counters with it.
9. BCD to Seven Segment Decoder in FPGA (a) Make a gate level design of a seven segment decoder, write to FPGA and test its functionality. (b) Test it with switches and seven segment display. Use output ports for connection to the display.
Self-study: 12 Hrs 1. Review FPGA board architecture, I/O pins, .pcf files; write and simulate basic gates in Verilog. 2. Practice half/full adder in Verilog using dataflow, behavioral, and structural styles; simulate outputs. 3. Study 4x1 MUX and 1x4 DEMUX; write Verilog code using case/conditional; simulate selector behavior. 4. Review SR, D, JK flip-flops; simulate ring and Johnson counters using D/T flip-flops. 5. Implement Boolean functions using 8:1 MUX; simulate and validate outputs via waveform. 6. Learn T, D, JK conversions; simulate each using Verilog and verify transitions. 7. Study ripple vs. synchronous counters; simulate 4-bit up/down counters and draw state diagrams.

8. Simulate SISO, SIPO, PISO, PIPO shift registers; implement BCD to 7-segment display with .pcf mapping.
Note: *A minimum of 10 experiments are to be completed.*
Textbooks 1. **Thomas L. Floyd**, *Digital Fundamentals*, 11th Edition, Pearson Education, 2017. 2. **Stephen Brown**, *Fundamentals of Digital Logic with Verilog Design*, 2nd Edition, McGraw Hill Education.
Reference books **M. Morris Mano**, **Michael D. Ciletti**, *Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog*, 6th Edition, Pearson India, 2018. **John F. Wakerly**, *Digital Design: Principles and Practices*, 5th Edition, Pearson, 2018.

CO Assessment Questions	
CO1	Design a one bit full adder using gates and implement and test it on board.
CO2	Convert a D flip-flop to T flip-flop and implement and test on board.
CO3	Design and implement a one bit subtractor in Verilog.
CO4	Design a 4:1 Multiplexer in Verilog and implement and test it on a tiny FPGA board.



Prepared By
Ms. Vidyamol K
Asst. Professor

SEMESTER-IV
SYLLABUS

24MAT421	**PROBABILITY DISTRIBUTIONS, NUMERICAL METHODS & TRANSFORMS**	**L**	**T**	**P**	**R**	**C**	**Year of Introduction**
		3	**0**	**0**	**0**	**3**	**2024**

Preamble: This course lays a strong foundation in probabilistic modelling, statistical inference, numerical methods, and transforms, equipping students with the tools to tackle complex real-world problems with confidence and precision. These concepts enable engineers to analyse data, model uncertainties, and design reliable, efficient systems across diverse engineering domains.
Prerequisite: Basics of statistics and probability laws, Fundamentals of differentiation and integration
Course Outcomes: After the completion of the course, the student will be able to

CO 1	Develop the ability to model and analyse real-world situations involving uncertainty using discrete and continuous probability distributions. **[Apply]**
CO 2	Apply statistical inferences concerning characteristics of a population based on attributes of samples drawn from the population.**[Apply]**
CO 3	Utilise numerical methods to differentiate and integrate multivariable functions, extending their application to advanced engineering models. **[Apply]**
CO 4	Determine the transforms of functions and understand their properties. **[Apply]**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	3	2	2	2							
CO 2	3	2	2	2							
CO 3	3	2	2	2	2						
CO 4	3	2	3								

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	√	√	√	√
Understand	√	√	√	√
Apply	√	√	√	√
Analyze				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-R]	Attendance	Theory [L-T]			Total Marks
		Assignment	Test-1	Test-2	
	5	10	12.5	12.5	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	2.5 hours

End Semester Examination [ESE]: Pattern			
PATTERN	**PART A**	**PART B**	**ESE Marks**
PATTERN 1	8 Questions, each question carries 3 marks Marks: (3x8 =24 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 9 marks. Marks: (9x4 = 36 marks)	60

SYLLABUS

MODULE I: (Probability Distributions)[9 Hours]

(**Text 1: Relevant topics from sections 3.1,3.2,3.3,3.4,3.6,4.1,4.2,4.3,4.4)**

Discrete and continuous random variables and their probability distributions, Expectation, mean and variance, Binomial distribution, Poisson distribution, Poisson approximation to the Binomial distribution, exponential and normal distributions.

Self-Study(14 hours):

1. Explain the probability mass function (PMF). Can you give an example of a discrete random variable?
2. Write down the significance of the expectation and variance in real-life contexts.
3. Under what conditions is a random variable said to follow a binomial distribution?
4. Derivation of the mean and variance of a Poisson distribution? Are they always equal?
5. Explain the Central Limit Theorem, and how does it relates to the normal distribution.
6. Identify which distribution to apply in real-life problems such as machine failures, survey results, or traffic patterns.

MODULE II: (Statistical Inference) [8 Hours]

(Text 1: Relevant topics from sections 1.1,7.1,7.2,8.1,8.2,8.3)

Population and samples, Sampling distribution of the mean and proportion (for large samples only), Confidence interval for single mean and single proportions (for large samples only). Test of hypotheses: Large sample test for single mean and single proportion, small sample t-tests for single mean and equality of means of normal population.

Self-Study (13 hours):

1. Write a short note on the difference between a population and a sample in statistics.
2. Identify the population and sample in a given real-world example (e.g., survey of college students).
3. Explain the difference between the standard deviation and the standard error.
4. Under what conditions can you apply the normal approximation for proportions?
5. When do you use the t-test instead of the Z-test? Explain with examples.
6. Relevance of probability and statistics in your branch of study.

MODULE III: (Numerical Differentiation and Integration)[9 Hours]

(Text 2: Relevant topics from sections 19.3,19.5,21.1)

Newton's forward and backwards interpolation method, Lagrange's interpolation method, Solution of ordinary differential Equations-Euler and Classical Runge-Kutta method of second and fourth order, Numerical Integration- Trapezoidal rule and Simpson's rule.

Self-Study (13 hours):

1. How do you identify whether to use forward or backwards interpolation for a given data set with an example?
2. Explain the situations in which Lagrange's interpolation formula and Newton's methods can be applied.
3. What are the assumptions and limitations of Euler's method?
4. Review the motivation for using the Runge-Kutta methods over Euler's method.
5. Identify real-world problems where these numerical methods are applicable (e.g., physics, engineering, finance).

MODULE IV: (Transforms)[10Hours]

(Text 2: Relevant topics from sections 11.8,11.9)

(Text3: Relevant topics from sections 23.1,23.2,23.3,23.4,23.5,23.6,23.7,23.8,23.15)

Fourier transform and inverse Fourier transform, basic properties (without proof), Fourier sine and cosine transforms, inverse Fourier sine and cosine transform transforms, Z transform

Self-Study (14 hours):

1. Explain the types of functions that are suitable for applying the Fourier transform.
2. When do we prefer to use the sine or cosine transform over the general Fourier transform? Verify with examples.
3. Importance of Transforms in Your Branch of Study.
4. Write a note on the properties of the Z-transform.
5. How do the Fourier and Z-transforms differ in terms of domain (continuous vs. discrete)?

Text books

1. Devore J.L., "Probability and Statistics for Engineering and Sciences", Cengage learning, 9th edition.
2. Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2016.
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2017.

Reference books

1. N.P. Bali,Dr.Manish Goyal,Goyal Laxmi publication,8th Edition,2011
2. Steven C Chapra, Raymond P.Canale, Numerical methods for Engineers, McGraw-Hill education ,8th Edition,2021
3. Papoulis, A. & Pillai, S.U., Probability, Random Variables and Stochastic Processes, McGraw Hill. 4th edition,2002
4. Ross, S. M., Introduction to Probability and Statistics for Engineers and Scientists, Academic Press, 6th edition,2020
5. Dr.Sudhir kumar Pundir,Integral Transform methods in Science and Engg.,CBS Publishers & Distributors, 1st edition,2017.

NPTEL/SWAYAM Courses for reference:

1.Dharmaraja, S. (2022). *Introduction to Probability Theory and Statistics* [Video course]. National Programme on Technology Enhanced Learning (NPTEL), IIT Delhi. https://archive.nptel.ac.in/courses/111/102/111102160/

2. Numerical Methods By Prof. Ameeya Kumar Nayak, Prof. Sanjeev Kumar, IIT Roorkee

NPTEL :: Mathematics - NOC:Numerical methods

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours [36 hours]
	MODULE 1 [9 hours]	
1.1	Discrete random variables, Probability distributions of Discrete random variables	1
1.2	Expectation, Mean, Variance	1
1.3	Binomial Distribution	2

1.4	Poisson Distribution, Poisson approximation to the binomial distribution	1
1.5	Continuous random variables, Probability distributions of Discrete random variables	1
1.6	Exponential Distribution	1
1.7	Normal distribution	2
MODULE II [8 hours]		
2.1	Population and samples, Sampling distribution of the mean and proportion (for large samples only)	1
2.2	Confidence interval for single mean (for large samples only)	1
2.3	Confidence interval for single proportions (for large samples only)	1
2.4	Test of hypotheses:	1
2.5	Large sample test for single mean	1
2.6	Large sample test for the single proportion	1
2.7	small sample t-tests for single mean and equality of means of normal population	2
MODULE III [9 hours]		
3.1	Newton's forward & backwards interpolation method	2
3.2	Lagrange's interpolation method	1
3.3	Solution of ordinary differential equations-Euler method	1
3.4	Solution of ordinary differential equations- Classical Runge-Kutta method of second order	1
3.5	Solution of ordinary differential equations- Kutta method of fourth order	2
3.6	Numerical integration-Trapezoidal rule	1
3.7	Numerical integration- Simpson's rule	1
MODULE IV [10 hours]		
4.1	Fourier transform and inverse Fourier transform	2
4.2	Basic properties(without proof)	1

4.3	Fourier sine and cosine transforms	2
4.4	Inverse sine and cosine Fourier transform.	1
4.5	z transform	2
4.6	Properties of Z transform.	2
CO Assessment Questions		
CO1	1. A problem in Mechanics is given to three students A, B, C whose chances of solving it are ½ , 1/3 and ¼, respectively. What is the probability that the problem will be solved.**[Apply]** 2. If a random variable has a Poisson distribution such that P(1) = P(2) then find mean of the distribution and P(4).**[Analyze]** 3. The lifetime (in hours) of a water pump used at a construction site follows an exponential distribution with a mean lifetime of 2000 hours. (i) What is the probability that a pump fails before 1000 hours? (ii) What is the probability that a pump operates for more than 3000 hours without failure?**[Apply]** **Team Work**: 1. A company launches a new email marketing campaign. Based on past data, there's a 20% chance that any given customer will respond positively to the email. If the company sends the email to 15 customers: What is the probability that exactly 3 customers respond positively? What is the probability that at most 2 customers respond positively? How would the probability change if the success rate increased to 30%? 2. The amount of rainfall (in cm) during a storm at a construction site is modeled as a continuous random variable X with the following probability density function (PDF): $f(x) = \begin{cases} \frac{1}{5}, & 0 \le x \le 5 \\ 0, & \text{otherwise} \end{cases}$ (i) Verify whether f(x) is a valid probability density function. (ii) What is the probability that the rainfall during a storm is less than,2 cm? (iii) What is the probability that the rainfall is between 1 cm and 3 cm? Compare the answer of (ii) when rainfall is less than 3cm. and compare the answer of (iii) when rainfall is between 1.5cm and 3.5cm.	

CO2	1. Two independent samples of students from two colleges give the following heights (in cm): a. College A (n = 8): Mean = 170, SD = 6 b. College B (n = 10): Mean = 174, SD = 5 2. Test at 5% level whether the mean heights differ significantly.?**.[Apply]** 3. Explain the importance of random sampling in statistical inference.**[Understanding]** 4. In a survey of 600 people, 360 support a proposed law. Can we conclude at 1% significance level that the true proportion exceeds 0.55??**.[Apply]** **Team Work**: 1.Discuss and list examples of **Type I and Type II errors** in practical scenarios (e.g., drug approval, quality control, court verdicts). 2.Debate: Larger samples always give more accurate results in statistics."
CO3	1. Using Newton's method of interpolation find sin 52^0 from the data given below,when sin 45^0 = 0.7071, sin 50^0= 0.7660, sin 55^0 = 0.8192, sin 60^0 = 0.8660?**[Apply]** 2. From the following data find log 656 No. : 654 658 659 661 Log : 2.8156 2.8182 2.8189 2.8202 **[Apply]** 3. Use Trapezoidal rule to estimate the integral 02ex2dx taking intervals.**[Apply]** **Team Work**: Solve the ODE dydt= -2y+ e-t , y 0=1 , t ∈[0 , 5] using Runga Kutta method of 4^{th} order (step size= h = 0.1) and compare the answer obtained using MATLAB's ordinary differential equation solver.
CO4	1.Use the time-shifting property to find the Fourier transform of f(x – x_0) given the transform of f(x).**[Apply]** 2.Explain how the convolution theorem simplifies the process of solving differential equations using Fourier transforms. **[Apply]** **Team Work**: 1. Each team discusses and presents one **property** of Fourier or Z-transform (e.g., time shift, linearity, scaling).

	2. Each team researches an application of Fourier or Z-transform in engineering (e.g., image compression, signal filtering).

Prepared by,
Ms.Swapna Joseph ,Ms.Rani Thomas
ASH Department,SCET

24ECT402	**SIGNALS AND SYSTEMS**	**L**	**T**	**P**	**R**	**C**	**Year of Introduction**
		3	**1**	**0**	**0**	**4**	**2024**

Preamble: This course introduces the fundamental principles of signal representation, system behavior, time and frequency domain analysis, and transforms such as Fourier, Laplace, and Z-transform. By exploring both theoretical insights and practical applications, the course aims to build a strong mathematical and conceptual framework that underpins modern signal processing, control systems, telecommunications, and beyond.

Prerequisite: 24MAT121 Linear Algebra, Differential Equations & Laplace Transforms

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

CO 1	Apply the properties of signals and systems in continuous and discrete domains to classify them and apply sampling theorem to discretize continuous time signals **[Apply]**
CO 2	Analyze the signals in frequency domain using Fourier series, Fourier transform and Laplace transform and stability of LTI systems in continuous domain **[Analyze]**
CO 3	Analyze the signals in frequency domain using Fourier series, Fourier transform and Z transform and stability of LTI systems in discrete domain .**[Analyze]**
CO 4	Design and implement signals and systems using MATLAB tools and techniques. **[Create]**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11
CO1	3	3			3						2
CO2	3	3			3						2
CO3	3	3			3						2
CO4	3	2			3						2

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember				
Understand	√	√	√	√
Apply	√	√	√	√
Analyze	√	√	√	√
Evaluate				
Create				

Mark Distribution of CIA

	Lecture [L]	

Course Structure [L-T-P-R]	Attendance	Assignment	Test-1	Test-2	Total Marks
3-1-0-0	5	10	12.5	12.5	40

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	2.5 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	8 Questions (2 Questions from each module), each question carries 3 marks Marks: (3x8 =24 marks)	2 questions will be given from each module, out of which 1 should be answered. Each question can have a maximum of two sub-divisions. Each question carries 9 marks. Marks: (9x4 = 36 marks)	60

SYLLABUS

MODULE I: Representation of Signals and Systems (12 hours)

Elementary Signals, Classification and representation of continuous time and discrete time signals - Signal operations, Continuous time and discrete time systems – Classification, Properties.

Representation of systems - Differential equation representation of continuous time systems. Difference equation representation of discrete systems. Continuous time LTI systems and convolution integral. Discrete time LTI systems and linear convolution. Stability and causality of LTI systems.

Self-Study (18 hrs):

1. Record different signals (e.g., heartbeat, speech, music, temperature data) and classify each as continuous-time or discrete-time, periodic/non-periodic, even/odd, etc.
2. Take an audio file and apply time-shifting, time reversal, time scaling and amplitude scaling. Play the modified audio and observe the effect.

3. Record a short sentence and convolve it with an impulse response (e.g., room acoustics) to simulate reverb
4. Apply convolution kernels to images to study blurring/smoothening, edge detection, sharpening etc
5. Assignment submission of NPTEL course **Principles of Signals and Systems**

MODULE II:Frequency Domain Representation of Continuous time Signals (12 hours)

Frequency domain representation of continuous time signals - Continuous time Fourier series and its properties. Continuous time Fourier transform and its properties. Convergence and Gibbs phenomenon. Review of Laplace Transform, ROC of Transfer function, Properties of ROC, Stability and causality conditions. Relation between Fourier and Laplace transforms

Analysis of LTI systems using Laplace and Fourier transforms. Concept of transfer function, Frequency response, Magnitude and phase response

Self-Study (18 hrs):

1. Record any periodic signal and decompose it into Fourier series. Plot and compare original and reconstructed signals using harmonics. Understand frequency content and observe Gibbs phenomenon near discontinuities.
2. Simulate an audio equalizer system
3. Take a non-periodic signal. Compute and plot the Fourier Transform. Verify properties: linearity, time-shifting, scaling, etc. and visualize how time-domain operations affect frequency content.
4. Assignment submission of NPTEL course **Principles of Signals and Systems**

MODULE III : Frequency Domain Representation of Discrete time Signals (13 hours)

Frequency domain representation of discrete time signals- Discrete time Fourier series for discrete periodic signals. Properties of DTFS.Discrete Time Fourier Transform (DTFT) and its properties. Analysis of discrete time LTI systems using DTFT. Magnitude and phase response.

Z transform, ROC, Inverse transform, properties, Unilateral Z transform. Relation between DTFT and Z-Transform, Analysis of discrete time LTI systems using Z transforms, Transfer function. Stability and causality using Z transform.

Self-Study (18 hrs):

1. Design a digital filter for processing real time signals
2. Design and implement a filter to remove background noise from voice recordings.
3. Design a simple signal analyzer that takes audio input and shows its frequency components in real-time.
4. Assignment submission of NPTEL course **Principles of Signals and Systems**

MODULE IV: Sampling theorem and MATLAB for Signals and Systems (11 hours)

Sampling of continuous time signals, Sampling theorem for low pass signals, aliasing & reconstruction.

MATLAB for Signals and Systems: Signal Generation in MATLAB (Continuous and Discrete), Verification of the Sampling Theorem, Linear Convolution of Signals, Computation and Plotting of Fourier Series, Laplace Transform, Z-Transform, and Discrete-Time Fourier Transform (DTFT), System Response Analysis Using Laplace and Z-Transform Techniques

Self-Study (18 hrs):

1. Record an audio signal, sample it at various rates (below, at, and above Nyquist), and reconstruct it to study aliasing.
2. Create a GUI or animation that visually demonstrates how aliasing distorts different signals when undersampled.
3. Assignment submission of NPTEL course **Principles of Signals and Systems**

Text books

1. Alan V. Oppenheim and Alan Willsky, Signals and Systems, PHI, 2/e, 2009
2. Simon Haykin, Signals & Systems, John Wiley, 2/e, 2003

Reference books

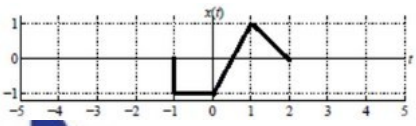
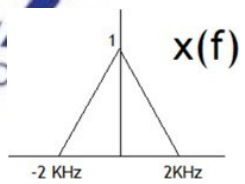
1. B P. Lathi, Principles of Signal Processing & Linear systems, Oxford University Press.
2. Anand Kumar, Signals and Systems, PHI, 3/e, 2013
3. P Ramakrishna Rao, Shankar Prakriya, Signals and System, MCGraw Hill Edn 2013
4. Rodger E. Ziemer, Signals & Systems - Continuous and Discrete, Pearson, 4/e, 2013

NPTEL/SWAYAM Courses for reference:

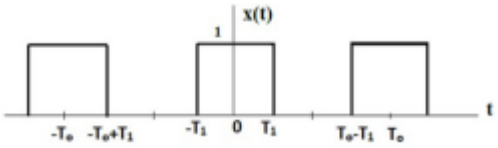
1. NPTEL :: Signals and Systems- IISER Bhopal
   https://onlinecourses.nptel.ac.in/noc25_ee78/preview
2. NPTEL :: Principles of Signals and Systems
   https://onlinecourses.nptel.ac.in/noc20_ee15/preview

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours [48 hours]
	MODULE I [12 hours]	
1.1	Elementary Signals, Classification and representation of continuous time and discrete time signals - Signal operations	3
1.2	Continuous time and discrete time systems – Classification, Properties.	3

1.3	Representation of systems - Differential equation representation of continuous time systems. Difference equation representation of discrete systems	1
1.4	Continuous time LTI systems and convolution integral	2
1.5	Discrete time LTI systems and linear convolution	2
1.6	Stability and causality of LTI systems	1
MODULE II [12 hours]		
2.1	Frequency domain representation of continuous time signals - Continuous time Fourier series and its properties. Continuous time Fourier transform and its properties. Convergence and Gibbs phenomenon.	5
2.2	Review of Laplace Transform, ROC of Transfer function, Properties of ROC, Stability and causality conditions. Relation between Fourier and Laplace transforms	3
2.3	Analysis of LTI systems using Laplace and Fourier transforms. Concept of transfer function, Frequency response, Magnitude and phase response	4
MODULE III [13 hours]		
3.1	Frequency domain representation of discrete time signals- Discrete time Fourier series for discrete periodic signals. Properties of DTFS.	3
3.2	Discrete Time Fourier Transform (DTFT) and its properties. Analysis of discrete time LTI systems using DTFT. Magnitude and phase response.	4
3.3	Z transform, ROC, Inverse transform, properties, Unilateral Z transform. Relation between DTFT and Z-Transform	4
3.4	Analysis of discrete time LTI systems using Z transforms, Transfer function. Stability and causality using Z transform.	2
MODULE IV [11 hours]		
4.1	Sampling of continuous time signals, Sampling theorem for low pass signals, aliasing & reconstruction.	3
4.2	Signal Generation in MATLAB (Continuous and Discrete), Verification of the Sampling Theorem, Linear Convolution of Signals	3
4.3	Computation and Plotting of Fourier Series, Laplace Transform, Z-Transform, and Discrete-Time Fourier Transform (DTFT) using MATLAB	3
4.4	System Response Analysis Using Laplace and Z-Transform Techniques using MATLAB	2
CO Assessment Questions		

CO-1	**3-Mark Questions** 1. Demonstrate the relationship between Unit step, Unit ramp and Unit Impulse functions. (*Understand*) 2. Determine energy of the signal x(t) = $e^{-2t}u(t)$. (*Understand*) 3. Find the Nyquist rate and Nyquist interval of the following signal **x(t) = 3 sin 100π t + 2 cos 200πt.** (*Apply*) **9-Mark Questions** 1. A discrete time sequence is given by x(n) = (1,1,1,1,2,2). Sketch 1) x(n) – x(n-2), (2) x(n) u(n+2). (*Apply*) 2. Evaluate the continuous time convolution integral for the following with proper plots. (*Apply*) y(t) = {u(t) - u(t - 2)} * u(t) 3. Given x(t). Sketch a . x(-t), b. x(t+2),c. x(t-1), d. x(t/2), e. x(2t). (*Apply*)  4. Consider the continuous time band-limited signal x(t) with a spectrum x(f) as shown in figure. Sketch the spectrum of the discrete time signals $x_1[n]$ and $x_2[n]$ obtained from x(t) by sampling at 5 KHz and 3 KHz respectively. (*Apply*)  Sample assignment questions: 1. Traffic signal monitoring- Traffic sensor data is a discrete time signal, Suggest a sampling rate for collecting traffic data, How would you model the traffic flow as a signal, What would be the effect if sampling is too low or fast
CO-2	**3-Mark Questions** 1. Find Laplace Transform and sketch ROC for the signal x(t) = e^{2t} u(t) + e^{-3t} u(t). (*Apply*) 2. State and prove differentiation property of CTFT. (*Understand*) **9-Mark Questions**

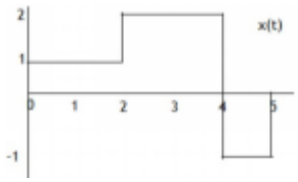
1. Find the complex exponential Fourier series for the function shown for To=4,8. (*Apply*)



2. A second order LTI system is described by the given differential equation. Use Laplace Transform to determine the transfer function of the system. (*Apply*)

$$\frac{d^2}{dt^2}y(t) + 4\frac{d}{dt}y(t) + 3y(t) = 4x(t) + 2\frac{d}{dt}x(t)$$

3. Determine FT of the signal given below. (*Apply*)



4. Determine the system response y(t) for a system given below to an input **x(t)=e^{3t}u(t).** (*Apply*)

$$H(s)=\frac{2s^2+6s+6}{s^2+3s+2}$$

CO-3	**3-Mark Questions** 1. Derive the relation between DTFT and Z transform. (*Understand*) 2. State and prove differentiation property of DTFT. (*Understand*) **9-Mark Questions** 1. Compute DTFS coefficients of the given discrete time signal. Plot its magnitude and frequency spectrum $x[n] = cos\left(\frac{6\pi}{13}n + \frac{\pi}{6}\right)$ (*Apply*) 2. Determine the DTFT of the signal $x[n]$ as given below. (*Apply*) $x\,[n] = 3, -10 \le n < 0$ $-3, 0 \le n \le 10$ $0, elsewhere$ 3. Evaluate the inverse Z-Transform by partial fraction method for the given X(z). (*Apply*) $X(z) = \frac{3-\frac{5}{6}z^{-1}}{(1-\frac{1}{4}z^{-1})(1-\frac{1}{3}z^{-1})} \quad |z| > \frac{1}{3}$ 4. Obtain the transfer function and impulse response of the system with difference equation $y[n] + (1/6)\,y[n-1] - y[n-2] = 3x[n] - (1/6)\,x[n-1]$ and analyze stability and causality. (*Analyze*)
CO-4	**3-Mark Questions** 1. Write MATLAB code to find convolution of the following two sequences using DTFT. (*Create*) $x_1[n] = [\,1, 2, 3, 1\,],\ x_2[n] = [\,1, 2, 1, -1\,]$ **9-Mark Questions** 1. Write MATLAB code to verify sampling theorem (*Create*) **Sample assignment questions:** (To be done using MATLAB Tools) 1. Automatic speech recognition 2. Face detection 3. Emotion detection from facial images 4. De noising in images and sound signals 5. Audio signal analysis- Record a short audio clip- Plot its waveform and analyze if it is periodic or aperiodic, apply a basic low pass filter and describe the effect

Prepared by

Ms. Naiji Joseph, Assistant Professor,ECE

24ECT403	Linear Integrated Circuits	L	T	P	R	C	Year of Introduction
		3	1	0	0	4	2024

Preamble: This course aims to develop the knowledge and skills required to analyze, design, and implement linear analog circuits using both discrete components and linear integrated circuits (ICs)

Prerequisite: 24EST104 Fundamentals of Electrical & Electronics Engineering

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

CO 1	Understand the concepts of operational amplifiers and differential amplifier configurations.[**Understand]**
CO 2	Design operational amplifier circuits for various applications.**[Apply/Design]**
CO 3	Analyze oscillators, multivibrators, active filters, and voltage regulators using fundamental electronic principles.**[Apply]**
CO4	Analyze the basic principle of timers,PLL and data converters.**[Apply]**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2									2
CO2	3	2	3	3							2
CO3	3		3	3							2
C04	3	2	3	3							2

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	√	√	√	√
Understand	√	√	√	√
Apply	√	√	√	√
Analyze	√	√		√
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-R]	Lecture [L]				
	Attendance	Assignment	Test-1	Test-2	Total Marks
3-1-0-0	5	10	12.5	12.5	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	2.5 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	8 Questions (2 Questions from each module), each question carries 3 marks Marks: (3x8 =24 marks)	2 questions will be given from each module, out of which 1 should be answered. Each question can have a maximum of two sub-divisions. Each question carries 9 marks. Marks: (9x4 = 36 marks)	60

SYLLABUS

MODULE I (12 hours)

Differential Amplifiers: Differential amplifier configurations using BJT- differential and common mode gains, CMRR, input and output resistance, voltage gain,constant current bias, constant current source.

Concept of current mirror: two-transistor current mirror, Wilson and Widlar current mirrors.

Operational amplifiers (Op Amps): The 741 Op Amp, Block diagram, Ideal Op Amp parameters, typical parameter values for 741, equivalent circuit, open loop configurations, voltage transfer curve, frequency response curve.

Op Amp with negative feedback: General concept of Voltage Series,Voltage Shunt, Current Series and Current Shunt negative feedback, Op Amp circuits with Voltage Series and Voltage Shunt feedback.

Self Study(15 hrs):

1. Set up BJT differential amplifiers using 2N3904 or BC547 .Use Function Generator to give differential input .Measure output swing, bias voltages, and CMRR.
2. Take a datasheet circuit (e.g., LM741 or LM324) and redraw the internal schematic. Annotate:Differential pair,Current mirrors,Compensation network.
3. Compare datasheets for multiple Op-Amps (e.g., LM741 vs TL081 vs LM358).Extract: Open loop gain, CMRR, slew rate, input offset voltage and create a comparison table
4. Build and simulate a BJT differential amp in LTspice.Compare theoretical vs simulated values of V,CE, I,C,gain.

MODULE II (11 hours)

Configurations of Op Amp : Virtual ground concept,Analysis of inverting and non-inverting amplifiers for closed loop gain,Input Resistance and Output Resistance.

Op Amp applications: Summer, Voltage Follower, Differential and Instrumentation Amplifiers, Voltage to Current and Current to Voltage converters, Integrator, Differentiator, Precision Rectifiers, Comparators,Schmitt Triggers, Log and Antilog amplifiers.

Self Study(20 hrs):

1. Write a short explanation of what virtual ground means in an inverting amplifier.Sketch the current paths in an inverting Op-Amp circuit showing virtual ground assumption.
2. Simulate Integrator & Differentiator and apply sinusoidal and square wave inputs. Observe waveform transformation.
3. Choose one application (e.g., Comparator in ADC, Integrator in control systems).Find and summarize a real-world circuit or product that uses this Op-Amp function.
4. Compare three different Op-Amps (e.g., LM741, TL081, OP07) for:Slew rate,Input offset voltage,Bandwidth.Use datasheets and simulate the same application with each.

MODULE III (11 hours)

Oscillators and Multivibrators: Phase Shift and Wien-bridge Oscillators,Triangular and Sawtooth waveform generators, Astable and Monostable multivibrators.
Active filters: Comparison with passive filters, First and Second order Low pass, High pass, Band pass and Band Reject active filters, State Variable filters.
Voltage Regulators: Fixed and Adjustable voltage regulators, IC 723 –Low voltage and High voltage configurations, Current boosting, Current limiting, Short circuit and Fold-back protection.

Self Study(20 hrs):

1. Design a Wien-Bridge oscillator and simulate it in a circuit simulator like LTSpice or Multisim. Focus on adjusting the resistors and capacitors to change the frequency.
2. Design a regulated power supply using a voltage regulator IC like the LM7812 or LM317 to convert an input voltage to a stable output voltage for a specific load.
3. Use multiple band-pass filters to create a basic audio equalizer. The equalizer will allow you to adjust different frequency bands of an audio signal.

MODULE IV (12 hours)

Timer and VCO: Timer IC 555 - Functional diagram, Astable and monostable operations, Basic concepts of Voltage Controlled Oscillator and application of VCO IC LM566.
Phase Locked Loop: Basic building block, Operation, Closed loop analysis, Lock and capture range, Applications of PLL, PLL IC565. **Data Converters:** Digital to Analog converters, Specifications, Weighted resistor type and R-2R Ladder type. Analog to Digital Converters: Specifications, Flash type and Successive approximation type.
Self Study(19 hrs):

1. Build an Astable Multivibrator using the 555 Timer IC to generate a square wave output. Vary the resistor and capacitor values to change the frequency and observe how the output waveform changes.
2. Study the LM566 VCO IC and learn how to use it in a circuit where an input voltage adjusts the frequency of oscillation.
3. Implement a 4-bit or 8-bit DAC using weighted resistors, and measure the output voltage for different input digital codes.
4. Simulate an ADC and DAC in MATLAB or Simulink. Visualize how the system converts an analog signal to a digital form and then reconstructs it back into an analog signal.

Textbooks

1. Roy D. C. and S. B. Jain,Linear Integrated Circuits,New Age International,5/e, 2018
2. Franco S., Design with Operational Amplifiers and Analog Integrated Circuits,3/e,Tata McGraw Hill, 2008

Reference books

1. Sergio Franco,Design with Operational Amplifiers and Analog Integrated Circuits,Tata McGraw Hill,3/e, 2017
2. Gayakwad R. A., Op-Amps and Linear Integrated Circuits,Prentice Hall,4/e, 2015
3. Botkar K. R.,Integrated Circuits,Khanna Publishers,10/e, 2013
4. R.F. Coughlin & Fredrick Driscoll,Operational Amplifiers & Linear Integrated Circuits,PHI,6/e, 2000
5. David A. Bell,Operational Amplifiers & Linear ICs,Oxford University Press,3/e, 2011
6. Sedra A. S. and K. C.Smith,Microelectronic Circuits,Oxford University Press,6/e, 2013

NPTEL/SWAYAM Courses for reference:

1. NPTEL : Analog Circuits,IIT Bombay
   https://nptel.ac.in/courses/117101106

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours [46 hours]
	MODULE 1 [12 hours]	
1.1	Differential amplifier configurations using BJT- differential and common mode gains	1
1.2	CMRR, input and output resistance, voltage gain,constant current bias, constant current source.	2
1.3	**Concept of current mirror:** two-transistor current mirror, Wilson and Widlar current mirrors.	2
1.4	The 741 Op Amp, Block diagram, Ideal Op Amp parameters, typical parameter values for 741,	1
1.5	equivalent circuit, open loop configurations, voltage transfer curve, frequency response curve.	2

1.6	**Op Amp with negative feedback:** General concept of Voltage Series,Voltage Shunt, Current Series and Current Shunt negative feedback	2
1.7	Op Amp circuits with Voltage Series and Voltage Shunt feedback	2
MODULE II [11 hours]		
2.1	**Configurations of Op Amp :**Virtual ground concept,Analysis of inverting and non-inverting amplifiers for closed loop gain,Input Resistance and Output Resistance.	2
2.2	**Op Amp applications:** Summer, Voltage Follower, Differential and Instrumentation Amplifiers	3
2.3	Voltage to Current and Current to Voltage converters	2
2.4	Integrator, Differentiator, Precision Rectifiers, Comparators,Schmitt Triggers, Log and Antilog amplifiers.	2
2.5	**Active filters:** Comparison with passive filters, First and Second order Low pass, High pass, Band pass and Band Reject active filters, State Variable filters.	2
MODULE III [11 hours]		
3.1	**Oscillators and Multivibrators**: Phase Shift and Wien-bridge Oscillators.	2
3.2	Triangular and Sawtooth waveform generators	2
3.3	Astable and Monostable multivibrators.	2
3.4	**Active filters:** Comparison with passive filters, First and Second order Low pass, High pass	3
3.5	Band pass and Band Reject active filters, State Variable filters.	2
MODULE IV [12 hours]		
4.1	**Timer and VCO:** Timer IC 555 - Functional diagram, Astable and monostable operations	2
4.2	Basic concepts of Voltage Controlled Oscillator and application of VCO IC LM566.	2
4.3	**Phase Locked Loop:** Basic building block, Operation, Closed loop analysis, Lock and capture range, Applications of PLL, PLL IC565.	3
4.4	**Data Converters:** Digital to Analog converters, Specifications.	1
4.5	Weighted resistor type and R-2R Ladder type.	2
4.6	Analog to Digital Converters: Specifications, Flash type and Successive approximation type	2
CO Assessment Questions		
CO-1	3-Mark Questions 1. Differentiate between the open loop configurations of inverting and non-inverting amplifiers.*(Analyze)* 9-Mark Questions	

	1. Explain the block diagram of an operational amplifier. List out any four ideal op amp characteristics.*(Understand)* 2. Discuss the transfer characteristics of differential amplifiers.(*(Analyze)*
CO-2	3-Mark Questions 1. Discuss the concept of virtual ground in inverting amplifiers.*(Analyze)* 9-Mark Questions 1. Derive the equation for closed loop voltage gain, input and output resistance of voltage shunt feedback amplifier.*(Analyze)* 2. Derive the equation for the output voltage for an instrumentation amplifier using op amps.*(Analyze)* Sample assignment questions: 1. 1.Design a composite amplifier using both inverting and non-inverting configurations to achieve a specific gain and impedance profile. Provide a detailed circuit diagram, analysis, and justification.
CO-3	3-Mark Questions 1. Design a notch filter to eliminate power supply hum (50FIz).*(Analyze)* 2. Design a RC Phase Shift Oscillator for a frequency of oscillation of 600 Hz using µA 74l.*(Analyze)* 9-Mark Questions 1. Explain the working of a monostable multivibrator using 741 Derive the equation for pulse width.*(Analyze)* *2.* Derive the equation for voltage gain for first order low pass filter. Using the gain magnitude equation illustrates the variation of gain with respect to frequency. What is frequency scaling?*(Analyze)* Sample assignment questions: *1.* Design low-pass, high-pass, using op-amps and simulated frequency response, design calculations, and real-world applications
CO-4	3-Mark Questions 1. Explain how PLL can be used as a frequency multiplier.*(Analyze)* 9-Mark Questions 1. Draw the pin diagram of 555 timer I.C. Design a monostable multivibrator using 555 timer I.C for a pulse width of I ms. Draw the circuit diagram.*(Analyze)*

Prepared by

Ms.Reshma P S,AP,ECE

24ECR404		**L**	**T**	**P**	**R**	**C**	**Year of Introduction**

	MICROCONTROLLERS & EMBEDDED SYSTEMS	3	0	0	1	4	2024

Preamble: This course aims to analyze the microcontroller architecture and its programming.

Prerequisite: 24ECR304 Logic Circuit Design

Course Outcomes: After the completion of the course the student will be able to

CO 1	**Understand** the architecture of microcontrollers. **[Understand]**
CO 2	**Develop** microcontroller programs. **[Evaluate]**
CO 3	**Develop** various interfacing programs for microcontrollers. **[Evaluate]**
CO 4	**Analyze** the architecture of an embedded system. **[Analyze]**
CO 5	**Simulate/Implement** a typical embedded system using Embedded C/ Assembly Language Programming. **[Evaluate]**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	3										2
CO 2	3	3									2
CO 3	3	3			3						2
CO 4	3	3									2
CO 5	3	3	3	2	3			3	3		2

Assessment Pattern for Theory Component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember				
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyze	✓	✓	✓	✓

Evaluate			✓	
Create				

Assessment Pattern for Project Component			
Bloom's Category	**Continuous Assessment Tools**		
	Evaluation 1	**Evaluation 2**	**Report**
Remember			
Understand			✓
Apply			
Analyse	✓	✓	✓
Evaluate		✓	
Create	✓	✓	

Mark Distribution of CIA

Attendance	**Theory [L]**			**Project [R]**			**Total Marks**
	Assignment	**Test-1**	**Test-2**	**Evaluation 1**	**Evaluation-2**	**Report**	
5	5	7.5	7.5	10	10	5	50

Total Marks distribution

Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	50	50	2 hrs

End Semester Examination [ESE]: Pattern

PATTERN	**PART A**	**PART B**	**ESE Marks**

PATTERN 2	2 Questions from each module. Any full 6 Questions, each carrying 3 marks (6x3 =18 marks)	2 questions will be given from each module, of which 1 question should be answered. Each question can have a maximum of 3 subdivisions. Each question carries 8 marks. (4x8 = 32 marks)	50

SYLLABUS

MODULE I: Microcontroller Architecture (9 Hours)

Microcontroller Architecture – General internal architecture, Address bus, Data bus, control bus. The Microcontroller 8051: Features of 8051 microcontroller, architecture, pin out of 8051, program status word (PSW), accumulator, program counter. Memory organization – RAM & ROM, register banks and stack, Special Function Registers (SFRs), I/O port organization, Interrupts.

Self-Study (18 hrs):

1. Basic Information Extraction using 8051 datasheet: Operating voltage range, Clock frequency range, Number and size of timers, I/O port count and size
2. Use a simulator (e.g., 8051 Simulator IDE or Proteus) to execute simple instructions and observe how the PSW and Accumulator contents change after each instruction. Document your observations.
3. Write a small assembly code (like a loop or jump instruction), and trace how the program counter changes for each instruction. Show this as a flowchart.
4. Draw the internal memory map of 8051 showing internal RAM, ROM, SFRs, bit-addressable area, stack space, etc. Label and explain each section.
5. Write and run a short assembly program that uses multiple register banks and stack operations (PUSH/POP). Observe how stack memory is allocated.
6. Simulate or physically build an 8051-based circuit to blink LEDs using ports (P0–P3). Write a program to toggle specific pins and explain how the ports work internally (latch, pull-up).

MODULE II : Instruction Set of 8051 & Programming: (10 Hours)

Instruction Set of 8051 & Addressing modes: Classification of instruction set - Data transfer group, arithmetic group, logical group, branching group. Addressing modes - Types. Accessing the data from internal and external memory.
Programming 8051 Using Assembly Language: Introduction to 8051 assembly language programming. Concept of subroutine. Software delay programming.

Self-Study (18 hrs):

1. List the 5 addressing modes (Immediate, Register, Direct, Indirect, Indexed). For each: Define it, write 2 example instructions, explain how the operand is accessed
2. Draw a memory map of the 8051, indicating: Internal RAM (00H to 7FH), SFRs, Code memory (ROM), External memory range
3. Write assembly code to: Add two numbers, AND two numbers, Jump to a label if accumulator ≠ 0
4. Create a flowchart of a program using LCALL and RET. Include main routine and 2 subroutines (e.g., Delay, LED ON). Track how the program counter and stack behave.
5. Write a loop-based delay routine using NOP or decrement loop counters. Calculate actual delay time for a given crystal frequency (e.g., 12 MHz).
6. Blink an LED with a delay.

MODULE III : Programming 8051 Using Embedded C Language: (10 Hours)

Programming 8051 Using Embedded C Language: Port programming, Interfacing of – LED, LCD, Stepper Motor, DAC and ADC -- with 8051 and its programming.

Timer / Counter in 8051: Timer registers - Timer0, Timer1. Configuration of timer registers. Timer mode programming. Counter mode. Serial Communication in 8051: Serial communication – modes. Serial port programming – transmitting and receiving.

Self-Study (18 hrs):

1. Write Embedded C programs to:Set all bits of Port 1 to high, Toggle alternate bits of Port Create a running light pattern on Port 0
2. Interface an LED to P1.0 of 8051. Write an Embedded C program to blink it every 1 second using software delay or timer.
3. Connect a 16x2 LCD to Port 2. Write an Embedded C program to:Display “Hello 8051”
4. Write a program to: Rotate the stepper motor clockwise for 360°, then Stop for 1 second, Rotate counter-clockwise
5. Write a C program to generate a ramp waveform by increasing digital value in a loop and outputting via the port.
6. Interface ADC0804 to Port 1.Write an Embedded C program to: Read analog voltage input,Display digital output on LCD

MODULE IV : Introduction to Embedded Systems: (7 Hours)

Introduction to Embedded Systems: General Purpose vs Embedded system,Von Neumann and Harvard architecture, Components of embedded system hardware–Software embedded into the system –Embedded Processors - CPU architecture of ARM processor (ARM7) – CPU Bus Organization and Protocol.

Self-Study (18 hrs):

1. Create a comparison table highlighting at least 8 points of difference between:General-purpose systems and Embedded systems.
2. Diagram Analysis: Von Neumann vs Harvard Architecture
3. Choose one device (e.g., smart thermostat, pacemaker) and analyze: Its embedded hardware, Software functionality, Type of processor used, Architecture employed (Von Neumann or Harvard)
4. Draw and label the ARM7TDMI block diagram.
5. Research and analyse how each bus contributes to instruction execution in ARM

Textbooks

1. Muhammad Ali Mazidi Janice Gillispie Mazidi Rolin D. McKinlay, he 8051 Microcontroller and Embedded Systems Using Assembly and C, Prentice Hall -Inc, 2007
2. Steve Furber, "RM System-on-Chip Architecture", Addison-Wesley Educational Publishers Inc,2000 .

Reference books

1. Kenneth J Ayala Dhananjay V Gadre, The 8051 Microcontroller Architecture, Programming and Applications, Cengage Learning,2010
2. Steve Furber, "RM System-on-Chip Architecture", Addison-Wesley Educational Publishers Inc,2000 .
3. Joseph Yiu , "System-on-Chip Design with Arm(R) Cortex(R)-M Processors ",ARM Education Media , 2019.
4. 8051 Hardware Description Datasheet, Intel Corporation,1992
5. Lyla B Das, "Microprocessors and Microcontrollers",Pearson Education, 2011.

NPTEL/SWAYAM Courses for reference:

1. NPTEL : **Microprocessors and Microcontrollers** - IISc Bangalore 'https://nptel.ac.in/courses/106108100
2. NPTEL : **Microcontrollers and Applications** - IIT Kanpur https://nptel.ac.in/courses/117104072
3. NPTEL : **Embedded System Design With ARM** - IIT Kharagpur https://onlinecourses.nptel.ac.in/noc20_cs15/preview

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours [36 hours]
	MODULE I: (9 Hours)	

1	The Microcontroller 8051:	
1.1	Microcontroller Architecture – General internal architecture, Address bus, Data bus, control bus.	1
1.2	The Microcontroller 8051: Features of 8051 microcontroller, architecture, Pin out of 8051	2
1.3	program status word (PSW), accumulator, program counter.	1
1.4	Memory organization – RAM & ROM, register banks and stack,	2
1.5	Special Function Registers (SFRs), I/O port	1
1.6	I/O port organization, Interrupts.	2
MODULE II: (10 Hours)		
2	Instruction Set of 8051 & Addressing modes:	
2.1	Classification of instruction set - Data transfer group, arithmetic group, logical group, branching group.	3
2.2	Addressing modes - Types. Accessing the data from internal and external memory.	2
2.3	Programming 8051 Using Assembly Language: Introduction to 8051 assembly language programming.	3
2.4	Concept of subroutine. Software delay programming.	2
MODULE III: (10 Hours)		
3	Programming 8051 Using Embedded C Language:	
3.1	Port programming, Interfacing of – LED, LCD, Stepper Motor, DAC and ADC -- with 8051 and its programming.	4
3.2	Timer / Counter in 8051: Timer registers - Timer0, Timer1. Configuration of timer registers.	2
3.3	Timer mode programming. Counter mode.	2
3.4	Serial Communication in 8051: Serial communication – modes.	1
3.5	Serial port programming – transmitting and receiving.	1
MODULE IV: (7 Hours)		

4	Introduction to Embedded Systems:	
4.1	Introduction to Embedded Systems	1
4.2	General Purpose vs Embedded system, Von Neumann and Harvard architecture	1
4.3	Components of embedded system hardware–Software embedded into the system –Embedded Processors	2
4.4	CPU architecture of ARM processor (ARM7)	2
4.5	CPU Bus Organization and Protocol.	1
	PROJECT	
	It is mandatory that a course project shall be undertaken by a student for this subject. The course project can be performed as simulation/implementation of 8051/PIC/MSP/Arduino/Raspberry Pi-based interfacing boards/sensor modules.	
LESSON PLAN FOR PROJECT COMPONENT		
No. Topic	**Topic**	**No. of Hours (12)**
1	Preliminary Design of the Project	2
2	Zeroth presentation (4th week)	2
3	Project work - First Phase	2
4	Interim Presentation	2
5	Project work - Final Phase & Report writing (discussions in class during project hours)	2
6	Final Evaluation, Presentation and Exhibition (11th and 12th weeks)	2
CO Assessment Questions		
CO 1	1. Analyze the role of control signals in coordinating data flow within the 8051 microcontroller architecture. 2. Compare and contrast the use of general-purpose registers and Special Function Registers (SFRs) in managing tasks in 8051.	

	3. Evaluate the impact of memory organization on program execution efficiency in 8051-based systems. 4. How does the PSW influence conditional branching and flag manipulation in 8051 programming?
CO 2	1. Develop a modular program in assembly to perform matrix addition using register banks efficiently. 2. Write and analyze an embedded C program to toggle a pin using both polling and interrupt-based approaches—compare execution time. 3. Demonstrate the use of subroutines and stack management by implementing a recursive factorial function in assembly. 4. Construct an application in Embedded C to display a scrolling message on a 16x2 LCD. 5. Integrate timer delay with LED toggling and explain how software-based delays affect power consumption. 6. Optimize a loop-driven 8051 C program for blinking multiple LEDs in sequence using minimal memory and cycles.
CO 3	1. Design and implement an 8051-based application to read temperature data via ADC and display the result on an LCD. 2. Write a C program for 8051 to control the angle of a steppermotor motor. 3. Implement interfacing of an analog sensor with the 8051 microcontroller
CO 4	1. Analyze the advantages of ARM architecture over traditional 8-bit microcontrollers in embedded system design. 2. Compare Von Neumann and Harvard architectures in the context of embedded system performance and power efficiency. 3. Examine the role of memory hierarchy and cache in embedded processors like ARM7.
CO 5	Sample course projects:The below projects shall be done with the help of IDE for 8051/PIC/MSP/Arduino/Raspberry Pi-based interfacing boards/sensor modules. 1. Relay control 2. Distance measurement 3. Temperature measurement / Digital Thermometer 4. RF ID tags 5. Alphanumeric LCD display 6. OLED display Interfacing

Prepared by:

Ms. Binet Rose Devassy

Assistant Professor, Department of ECE

24ECL406	**Linear Integrated Circuits Lab**	**L**	**T**	**P**	**R**	**C**	**Year of Introduction**
		0	**0**	**3**	**0**	**2**	**2024**

Preamble: This lab aims to equip students with hands-on experience in designing and analyzing analog circuits using linear integrated circuits. Through experiments involving op-amps, timers, and converters , students gain practical skills in building and testing circuits such as amplifiers, filters, and waveform generators.

Prerequisite: 24ECT302 - Analog Circuits, 24ECL 307Analog Circuits Lab

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

CO1	Analyze the basic characteristics of analog integrated circuits using datasheets[**Analyze**]
CO2	Design and implement application circuits using analog ICs [**Apply**]
CO3	Simulate the application circuits with analog ICs using simulation tools [**Apply**]
CO4	Function effectively as an individual and in a team to accomplish the given task [**Apply**]

CO - PO MAPPING

CO	PO1	PO2	PO3	PO 4	PO5	PO 6	PO7	PO8	PO9	PO10	PO11
CO1	3	3									
CO2	3	2	2	2							2
CO3	3	2	3	2	3						2
CO4	3	3	2	2	3						

Assessment Pattern

Bloom's Category	Continuous Assessment Tools	
	Classwork	Test
Remember		
Understand	√	√
Apply	√	√
Analyze	√	
Evaluate	√	
Create	√	

Mark Distribution of CIA

Course Structure [L-T-P-R]	Attendance	Classwork	Internal Lab Exam	Total Marks
0-0-3-0	5	25	20	50

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	50	50	2 hours

End Semester Examination Pattern:

The following guidelines should be followed regarding award of marks

(a) Procedure/Preliminary Work/Design/Algorithm (10 Marks)
(b) Conduct of Experiment/Execution of Work/Programming (15 Marks)
(c) Result with Valid Inference/Quality of Output (10 Marks)
(d) Viva Voce (10 Marks)
(e) Record (5 Marks)

SYLLABUS- DETAILS OF EXPERIMENTS

Part A : Fundamentals of operational amplifiers and basic circuits [Minimum seven experiments are to be done]

1. Familiarization of Operational amplifiers - Inverting and Non inverting amplifiers, Integrator, Differentiator - frequency response, Adder, Comparators
2. Measurement of Op-Amp parameters
3. Difference Amplifier and Instrumentation amplifier
4. Schmitt trigger circuit
5. Astable and Monostable multivibrators
6. Waveform generators using Op Amps - Triangular and Sawtooth
7. Wien bridge oscillator - without & with amplitude stabilization
8. RC Phase shift Oscillator
9. Active first and second order filters (LPF, HPF, BPF and BRF)
10. Active Notch filter to eliminate the 50Hz power line frequency
11. Precision rectifiers

Part B – Application circuits using ICs [Minimum three experiments are to be done]

1. Astable and Monostable multivibrator using Timer IC NE555
2. DC power supply using IC 723: Low voltage and high voltage configurations, Short circuit and Fold-back protection.
3. A/D converters- counter ramp and flash type.
4. D/A Converters - R-2R ladder circuit
5. Study of PLL IC: free running, frequency lock range and capture range

Part C – Simulation experiments [The experiments shall be conducted using open tools such as QUCS, KiCad or variants of SPICE]

1.Simulation of any three circuits from experiments 3, 5, 6, 7, 8, 9, 10 and 11 of part A

2 . Simulation of experiments 3 or 4 from part B

**A minimum of 14 experiments must be performed compulsorily.*

Self-Study: 24 hrs

1. Study the datasheet of the µA741 Op-Amp
2. Study the conditions under which an RC circuit functions as an integrator or a differentiator
3. Identify and explain the significance of key op-amp parameter
4. Understand the frequency response and transfer functions of these filters.
5. Study RC Time Constant,Capacitor Behavior in AC Circuits etc.
6. Understand how op-amps can be configured to generate triangular and sawtooth

waveforms.

7. How does the quality factor Q affect the filter's effectiveness?

Textbooks

1. Linear Integrated Circuits D. Roy Choudhary and Shail B Jain New Age International Private Limited 6 th edition, 2021
2. Introduction to Pspice Using Orcad for Circuits and Electronics M. H. Rashid Pearson 3 rd edition, 2015

Reference books

1. Linear Integrated Circuits D Roy Choudhury, Shail Bala Jain New Age International (2018)
2. Op-Amps And Linear Integrated Circuits: Business Management Gayakwad PHI 2002

CO Assessment Questions

CO 1	1. Use data sheets of basic Analog Design and simulate a zero-crossing detector using an op-amp. Observe the output waveform for a sinusoidal input signal. 2. Voltage Regulator Simulation 3. Simulate a voltage regulator using IC 723. Vary the input voltage and observe the regulation behavior.g Integrated Circuits and design and implement application circuits using Analog ICs. 4. Measure important opamp parameters of μA 741 and compare them with the data provided in the data sheet 5. Design and implement a variable timer circuit using opamp 6. Design and implement a filter circuit to eliminate 50 Hz power line noise.
CO 2	1. To design and set up Wien bridge oscillator with & without amplitude stabilisation by using op-amps. 2. To design and set up the following Wave generator circuits using op-amp. 1) Square wave. 2) Tri-angular wave. 3) Saw-tooth wave. 3. To design and set up the following multi-vibrator circuits using op-amp. 1) Astable multivibrator for a frequency of 1 kHz. 2) Monostable multivibrator for a pulse width of 1ms.
CO 3	1. Design and simulate a zero-crossing detector using an op-amp. Observe the output waveform for a sinusoidal input signal. 2. Simulate a voltage regulator using IC 723. Vary the input voltage and observe the regulation behavior. 3. Design and simulate a counter ramp ADC

CO 4	1. Design and Simulation of a Multistage Audio Amplifier System using Op-Amps 2. Temperature-Controlled Fan using Op-Amps and Comparator Circuits 3. Power Supply Design using IC 723 (Adjustable Regulator)

Prepared by,
Ms. Siji Joseph
Asst. Prof
ECE Department
SCET

EDUCATION IS DEDICATION

24ECL407	**MICROCONTROLLER LAB**	**L**	**T**	**P**	**R**	**C**	**Year of Introduction**
		0	**0**	**3**	**0**	**2**	**2024**
Preamble: This laboratory course is designed to provide students with hands-on experience in microcontroller programming and interfacing using both Assembly and C							

languages. The course is structured into three parts, focusing on data manipulation, microcontroller interface development, and advanced microcontroller applications.

Prerequisite:
24ECL307-Logic Circuit Design and Simulation Lab

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

CO1	Develop microcontroller-based applications using Assembly and C programming languages.
CO2	Implement Microcontroller interfaces to various modules
CO3	Understand and perform implementation using any advanced microcontrollers like ARM or higher.
CO4	Understand Embedded System Design process.

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2								2
CO2	3	3	3	2	3			2				2
CO3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools	
	Classwork	Test
Remember		
Understand	√	√
Apply	√	√
Analyze	√	
Evaluate	√	
Create	√	

Mark Distribution of CIA

Attendance	Classwork *(Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record)*	Internal Lab Exam	Total Marks
5	25	20	50

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	50	50	2 hours

End Semester Examination Pattern:

The following guidelines should be followed regarding award of marks (a) Procedure/Preliminary Work/Design/Algorithm (10 Marks) (b) Conduct of Experiment/Execution of Work/Programming (15 Marks) (c) Result with Valid Inference/Quality of Output (10 Marks) (d) Viva Voce (10 Marks) (e) Record (5 Marks)
SYLLABUS- DETAILS OF EXPERIMENTS
PART A – Data manipulation experiments using Assembly language(Min 4 has to be completed)
1. Multiplication of two 16-bit numbers.
2. Largest/smallest from a series.
3. Sorting (Ascending/Descending) of data.
4. Matrix addition
5. LCM and HCF of two 8-bit numbers.
6. Code conversion – Hex to Decimal/ASCII to Decimal and vice versa.
PART B - Interface to Microcontroller Assembly/C language (Min 3 has to be completed)
1. Time delay generation and relay interface.
2. Display (LED/Seven segments/LCD) and keyboard interface.
3. ADC interface
4. DAC interface with waveform generation
5. Stepper motor for forward motion,Reverse motion and speed control
PART C - Interface with Advanced Microcontroller using C language (Min 3 has to be completed)
1. PWM generation for DC motor control.
2. Program to interface a temperature sensor and display the temperature in an LCD
3. UART interface to Bluetooth.
4. SPI/I2C interface to display
5. Program to blink an LED with a 1 second delay using a Real-Time Clock (RTC)
Note: *A minimum of 10 experiments are to be completed.*
Textbooks 1. The 8051 Microcontroller and Embedded Systems Using Assembly and C. Muhammad Ali Mazidi Janice Gillispie Mazidi Rolin D. McKinlayPrintice Hall -Inc 2. The 8051 Microcontroller Architecture, Programming and Applications, Kenneth J Ayala Dhananjay V Gadre, Cengage Learning
Reference books 1. 8051 Hardware Description, Datasheet, Intel Corporation 2. Microprocessors and Microcontrollers, Lyla B. Das, Pearson Education
Self-Study: 24 hrs
1. Design and develop a digital Voting machine

2. Design and develop a Traffic light controller with pedestrian crossing

CO Assessment Questions

CO1	Develop 8051 Microcontroller programs
CO2	Design and implement various interfaces to the 8051 Microcontroller
CO3	Design and implement an Embedded System using a 8051 microcontroller
CO4	Design and implement an Embedded System using an Arduino controller

.

Prepared By
Ms. Anju Babu
Asst.Prof, ECE

EDUCATION IS DEDICATION

24PWT208	**UHV II, Life skills and community work**	**L**	**T**	**P**	**R**	**C**	**Year of Introduction**
		1	**0**	**0**	**0**	**1**	**2024**

Preamble: This course aims to foster holistic development by integrating Universal Human Values (UHV II), essential life skills, and community engagement. Through self-reflection, discussion, and experiential learning, students will develop ethical awareness, emotional intelligence, and a sense of social responsibility. The course encourages active citizenship by engaging students in real-life community work, enabling them to apply values and skills for societal transformation.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Demonstrate an understanding of harmony in the self, family, society, nature, and existence by applying the principles of universal human values to reflect on ethical living, responsible relationships, ecological balance, and professional conduct. **[Evaluate]**
CO2	Apply principles of emotional intelligence, effective communication, and critical thinking to personal and professional contexts, and demonstrate the ability to manage time, solve problems, and interact empathetically and assertively. **[Apply]**
CO3	Demonstrate leadership, teamwork, and social responsibility by planning and implementing community-based initiatives that integrate human values, sustainable development principles, and participatory approaches, and critically reflect on their societal impact. **[Evaluate]**

CO – PO MAPPING

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

Assessment Pattern

Blooms Category	Continuous Assessment Tools			
	Test 1	Test 2	Assignment	Field Work
Remember	✓	✓		
Understand	✓	✓	✓	
Apply	✓	✓	✓	✓

Analyze	✓	✓	✓	✓
Evaluate			✓	✓
Create				✓

Mark Distribution of CIA

Course Structure [L-T-P-R]	Attendance	Theory [L]				Total Marks
		Assignment/Activity	Test-1	Test-2	Field Work	
1-0-0-0	**5**	**20**	**12.5**	**12.5**	**50**	**100**

The assignments shall be evaluated as part of the activities under Modules 1, 2, and 3. Field work shall constitute the self-study component of Module 4.

SYLLABUS

MODULE 1: Understanding the Self, Relationships, and Society (3 Hours)

Session 1: Course Introduction and Self-Exploration (1 hour)

Course Purpose & Motivation, Recap of UHV-I, What is Self-Exploration?, Natural Acceptance & Experiential Validation, Human Aspirations: Continuous Happiness & Prosperity

Activities:

- *Reflection Exercise:* "Who am I?" – Write 5 statements about self and categorize as physical/sentient
- *Group Discussion:* Share experiences validating a value (e.g., truthfulness) through personal observation

Session 2: Understanding the Human Being and Prosperity (1 hour)

Co-existence of 'I' and Body, Needs of 'Self' vs 'Body', Body as Instrument of 'I', Sanyam (self-regulation) & Health, True Prosperity vs Accumulation

Activities:

- *Case Study:* "A Day in My Life" – Identify physical vs happiness-based needs

- *Role Play:* "Balanced Lifestyle vs Overconsumption"

Session 3: Harmony in Relationships and Society (1 hour)

Justice in Human Relationships, Trust vs Competence, Respect vs Differentiation, Visualizing Undivided Society, Universal Order, Gratitude in Relationships

Activities:

- *Circle Discussion:* Role of gratitude in student-teacher relationships
- *Scenario Analysis:* Interpersonal conflict – analyze based on values of trust and respect
- *Exercise:* Map your relationship network and reflect on mutual happiness

MODULE 2: Harmony with Nature and Professional Ethics (3 Hours)

Session 1: Harmony in Nature and Existence (1 hour)

Harmony in Nature: Four Orders, Mutual Fulfilment, Recyclability, Self-regulation, Existence as Co-existence, Holistic Perception of Harmony

Activities:

- *Film Screening & Discussion:* "Home" – Reflection on human impact on environment
- *Group Task:* Trace a natural cycle (e.g., water or carbon) and discuss its harmony

Session 2: Human Values and Professional Ethics (1 hour)

Ethical Human Conduct: Definitiveness & Natural Acceptance, Professional Competence & Responsibility, Humanistic Education, Constitution, and Universal Order

Activities:

- *Debate:* "Technology – Boon or Bane for Nature?"
- *Reflective Writing:* "What does it mean to be an ethical engineer?"

Session 3: Path to Universal Human Order (1 hour)

Transition Strategy: Individual & Societal Level, People- & Eco-friendly Systems, Case Studies of Holistic Models

Activities:

- *Case Study Discussion:* Amul Cooperative Model / Barefoot College
- *Action Plan Activity:* Create a personal code of ethics and action plan as a future professional

MODULE 3 Life Skills for Personal and Professional Growth (3 Hours)

Emotional intelligence: Self-regulation, empathy, Communication: Listening, assertiveness, empathy-based interaction; Problem-solving, decision-making, and critical thinking, Time management, goal setting, and personal productivity

Activity 1: Empathy Circle – "Walking in Their Shoes"

Objective: To practice empathetic listening and perspective-taking.
Instructions:

- Students form groups of 4–5.
- Each member shares a brief real-life or imagined story involving emotional difficulty or a moral dilemma (max. 3 mins).
- Other members respond with only empathetic reflections (no advice or judgment).
- Debrief as a class: How does it feel to be truly heard? What makes listening difficult?

Activity 2: Communication Styles Role-Play
Objective: To differentiate between passive, aggressive, and assertive communication.
Instructions:

- In pairs or small groups, students enact 3 short scenarios (e.g., refusing extra work, asking for help, handling group conflict) using each style.
- Each group presents one version to the class, followed by reflection:
  - What was the impact of each style?
  - When is assertiveness most effective?

Activity 3: Critical Thinking Puzzle – "What's the Real Problem?"
Objective: To strengthen problem-identification and decision-making skills.
Instructions:

- Present a real-world case (e.g., project failure, peer conflict, missed deadline).
- In groups, students:
  - Identify the root cause(s),
  - Propose at least two solutions,
  - Discuss possible consequences.

- Each group shares findings with the class.

Activity 4: Time Audit and Productivity Planning
Objective: To improve time management through self-awareness and planning.
Instructions:

- Students reflect on and write down how they spent the previous day (hour by hour).
- Identify time wasters and productivity blocks.
- Using the SMART method, each student sets 1 academic and 1 personal goal with an action plan.

Activity 5: Emotional Regulation Check-In
Objective: To raise awareness of emotional triggers and calming strategies.
Instructions:

- Students list 3 situations that trigger frustration or anxiety.
- For each, they note:
  - Physical/emotional reactions,
  - Current coping strategies,
  - One new strategy (e.g., deep breathing, journaling, re-framing thoughts).
- Optionally, share coping ideas in small groups.

(Any three activities to be completed)

MODULE 4: Community Engagement and Social Responsibility (5 Hours)

Values, Leadership, and Social Responsibility: Leadership, initiative, and teamwork as personal and social values, Community service as a form of experiential value education, Civic sense and responsibilities of educated citizens
Gandhian Vision and Community Empowerment:Introduction to Gandhian concept of Village Republics, Rural self-sufficiency and non-violence in development, Institutional role in community upliftment
Tools for Sustainable Community Engagement: Importance of eco-friendly, decentralized development, Science and technology for rural empowerment, Participatory planning, implementation, and monitoring, Knowledge, fund, and stakeholder convergence in development
Application through Service Learning: Integrating learning from values and life skills into community work, Designing small student-led interventions, Reflecting on leadership, empathy, and impact

Self -Study/Field Work: 16 hours
Students will identify a local community need and engage in a minimum 16-hour field project (individually or in small teams) aligned with the values studied.

Examples:

- Environmental awareness campaign
- Literacy or peer mentoring program
- Senior care/home visits with structured reflection
- Water/energy conservation drive
- Organic Farming
- Artisans, Industries and Livelihood
- Basic Amenities

Text Book

1. R R Gaur, R Asthana, G P Bagaria, 2019 (2nd Revised Edition), A Foundation Course in Human Values and Professional Ethics. ISBN 978-93-87034-47-1, Excel Books, New Delhi.
2. Premvir Kapoor, Professional Ethics and Human Values, Khanna Book Publishing, New Delhi, 2022.
3. Goleman, D. (1995). Emotional Intelligence. New Delhi: Bloomsbury Publishing India Private Limited
4. B. K. Mitra, Personality Development and Soft Skills, 3rd ed. New Delhi, India: Oxford Univ. Press, 2019.
5. K.G. Balakrishnan, *Unnat Bharat Abhiyan: Transforming India through Village Empowerment*, 1st ed., Ministry of Education, Govt. of India, 2022.

Reference books

1. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and Harper Collins, USA
2. E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
3. S. R. Covey, *The 7 Habits of Highly Effective People*. New York, NY, USA: Free Press, 2004.
4. A. Kumar, *Youth and Social Transformation*. Jaipur, India: Rawat Publications, 2012.

NPTEL Course

1. Exploring human values: Visions of happiness of perfect Societies, Prof. A.K. Sharma, IIT Kanpur https://nptel.ac.in/courses/109104068
2. Developing Soft Skills and Personality, Prof. T. Ravichandran, IIT Kanpur https://onlinecourses.nptel.ac.in/noc22_hs77/preview
3. Corporate social responsibility, By Prof. Aradhna Malik, IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc21_mg54/preview

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours (14 hours)
	MODULE 1 (3 Hours)	
1.1	Course Introduction and Self-Exploration	1
1.2	Understanding the Human Being and Prosperity	1

1.3	Harmony in Relationships and Society	1
MODULE 2 (3 Hours)		
2.1	Harmony in Nature and Existence	1
2.2	Human Values and Professional Ethics	1
2.3	Path to Universal Human Order	1
MODULE 3 (3 Hours)		
3.1	Emotional intelligence	1
3.2	Communication:	1
3.3	Problem-solving, decision-making, and critical thinking, Time management, goal setting, and personal productivity	1
MODULE 4 (5 Hours)		
4.1	Values, Leadership, and Social Responsibility	1
4.2	Gandhian Vision and Community Empowerment:	1
4.3	Tools for Sustainable Community Engagement	1
4.4	Application through Service Learning	2
LESSON PLAN FOR FIELD WORK		
No.	**Topic**	**No. of Hours (16)**
1	Orientation & Need Identification	1
2	Proposal Submission:	1
3	Field Implementation	9

4	Reflection Session:	3
5	Final Submission	2
No.	**Field Work Assessment**	**50 marks**
1	Problem identification	5
2	Planning and organization	5
3	Execution and teamwork	15
4	Reflection and learning outcomes	10
5	Report and presentation	15
CO Assessment Questions		
CO1	1. What is the meaning of natural acceptance? 2. List the four levels of harmony discussed in the course. 3. Explain the difference between prosperity and accumulation. 4. How do trust and respect influence human relationships? 5. Apply the principle of Sanyam to your daily routine. What changes would you make? 6. How can you promote harmony in your classroom or hostel? 7. Analyze the current societal model in terms of human aspirations and values. 8. How does imbalance in nature reflect the lack of harmony at the human level?	
CO2	1. What are the key components of emotional intelligence, and why are they important in both personal and professional life? 2. Explain the difference between assertive and aggressive communication. How can this distinction improve interpersonal relationships? 3. Describe a situation where you faced a communication challenge. How would you apply assertiveness and empathy to handle it differently now?	

	4. Given a tight academic schedule and personal responsibilities, how would you apply time management techniques to maintain productivity and well-being?
CO3	1. What are the core values promoted through Gandhian principles of rural development? 2. List the essential elements of participatory planning in a community project. 3. Explain how eco-friendly, decentralized development contributes to rural sustainability. 4. Describe the relationship between civic responsibility and community engagement for students. 5. How would you apply leadership and teamwork skills in organizing a community-based awareness campaign on environmental sustainability? 6. Devise a plan to involve your peers in a service-learning activity that addresses a local issue. 7. Analyze the roles of different stakeholders (educational institutions, local governance, NGOs) in the successful execution of community projects. 8. Compare two community interventions and identify the factors that led to the success or limitations of each.

Prepared by:
Ms. Vini Valsan
Department of ASH, SCET

EDUCATION IS DEDICATION

24ECE411	**ELECTRONIC INSTRUMENTATION**	**L**	**T**	**P**	**R**	**C**	**Year of Introduction**
		3	**0**	**0**	**0**	**3**	**2024**
Preamble: This course aims to equip students with foundational knowledge and practical understanding of electronic measurement systems, focusing on transducers, signal conditioning, data acquisition systems, and the use of instruments for measuring physical parameters in engineering applications.							
Prerequisite: Basic Electrical and Electronics Engineering, Network Theory, and Analog Circuits.							
Course Outcomes: After the completion of the course, the student will be able to							

CO 1	Understand principles of measurement systems and their characteristics [**Understand]**
CO 2	Analyze different types of transducers and signal conditioning circuits **[Analyze]**
CO 3	Apply the operation and application of electronic measuring instruments.**[Apply]**
CO 4	Apply instrumentation techniques for measurement of physical parameters. [**Apply**]

CO - PO MAPPING

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

Assessment Pattern

Bloom's Category	**Continuous Assessment Tools**			**End Semester Examination**
	Test1	**Test 2**	**Other tools**	
Remember	√	√	√	√
Understand	√	√	√	√
Apply	√	√	√	√
Analyze	√			
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-R]	**Lecture [L]**				
	Attendance	**Assignment**	**Test-1**	**Test-2**	**Total Marks**
3-0-0-0	5	10	12.5	12.5	40

Total Mark distribution

Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	2.5 hours

End Semester Examination [ESE]: Pattern

PATTERN	**PART A**	**PART B**	**ESE Marks**

PATTERN 1	8 Questions (2 Questions from each module), each question carries 3 marks Marks: (3x8 =24 marks)	2 questions will be given from each module, out of which 1 should be answered. Each question can have a maximum of two sub-divisions. Each question carries 9 marks. Marks: (9x4 = 36 marks)	60

SYLLABUS

MODULE I: Measurement Fundamentals and Characteristics(9 hours)

Introduction to measurement systems and Functional elements- Static characteristics: accuracy, precision, resolution - Dynamic Characteristics :fidelity, lag, response time-Calibration techniques-Introduction and Classification of transducers: Active, passive, analog, digital-Types of transducers:Resistive (RTD, strain gauge), Inductive (LVDT,RVDT), Capacitive, Piezoelectric.

Self- Study: 13 Hrs

1. Analyze the role of dynamic characteristics such as response time, fidelity, and lag in the selection of sensors for real-time heart rate monitoring using wearable devices..
2. Classify transducers based on operating principle: active vs. passive and analog vs. digital.

MODULE II: Signal Conditioning and Data Acquisition(9 hours)

Signal Conditioning: Introduction and Purpose-AC Vs DC signal conditioning,Operational amplifiers in instrumentation-Filters: low-pass, high-pass, band-pass-Analog to Digital Converters (ADC) and Digital to Analog Converters (DAC)-Sample & hold circuits- Multiplexers-Data Acquisition System architecture

Self- Study: 13 Hrs

1. Classify low-pass, high-pass, and band-pass filters, and analyze their roles in real-time applications such as audio processing, vibration monitoring, and ECG noise reduction.
2. Analyze the differences between ADC and DAC in real-time systems such as digital audio devices, smart sensors, and micro controller-based data logging.
3. Examine how filtering and amplification improve signal quality in real-time applications such as noise-free data logging from piezoelectric vibration sensors.

MODULE III:Electronic Measurement Instruments(9 hours)

DVM, DMM, Function generators- CRO: construction,operation and measurements-Advanced CRO types: Digital Storage Oscilloscope (DSO)-Introduction to Spectrum

analyzers-Frequency counters and time interval measurements-Display technologies: 7-segment, LCD, LED

Self- Study: 14 Hrs

1. Identify the key functions of a function generator and explore its application in testing audio amplifiers used in home theater systems or musical instruments.
2. Analyze the integration of LCD and LED displays in smart meters or portable medical devices like digital thermometers and ECG monitors.
3. Compare traditional CROs with Digital Storage Oscilloscopes (DSOs) in monitoring digital communication signals, such as USB or UART protocols in embedded systems.

MODULE IV:Applications of Instrumentation(9 hours)

Measurement of Temperature (thermistors, RTDs), Pressure, Displacement,Velocity-Biomedical instrumentation overview (ECG, temperature sensing)-Smart sensors and wireless instrumentation basics--Case studies: Instrumentation in industry, aerospace, and healthcare

Self- Study: 14 Hrs

1. Analyze the role of wireless instrumentation in enabling continuous health data tracking in remote patient monitoring systems.
2. Examine how sensor networks are utilized in healthcare settings such as ICUs and telemedicine platforms for real-time patient monitoring.
3. Analyze the role of AI and IoT in enhancing real-time monitoring and automation in modern instrumentation systems used in healthcare, manufacturing, or energy sectors.

Textbooks

1. H. S. Kalsi, *Electronic Instrumentation*, 3rd ed. New Delhi, India: McGraw-Hill Education, 2012.
2. A. K. Sawhney, *A Course in Electrical and Electronic Measurements and Instrumentation*, 4th ed. New Delhi, India: Dhanpat Rai & Co., 2012

Reference books

1. D. A. Bell, *Electronic Instrumentation and Measurements*, 3rd ed. New York, NY, USA: Oxford University Press, 2013.
2. E. O. Doebelin, *Measurement Systems: Application and Design*, 5th ed. New York, NY, USA: McGraw-Hill, 2003.

NPTEL/SWAYAM Courses for reference:

1. NPTEL:: Electronic Systems Design: Hands-on Circuits and PCB- Design with CAD Software- IIT Delhi
   https://onlinecourses.nptel.ac.in/noc25_ee163/preview

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours

		[36 hours]
MODULE 1 [9 hours]		
1.1	Introduction to measurement systems and Functional elements	2
1.2	Static Characteristics and Dynamic Characteristics	2
1.3	Introduction and Classification of transducers	3
1.4	Types of transducers	2
MODULE II [9 hours]		
2.1	Signal Conditioning: Introduction and Purpose	1
2.2	AC Vs DC signal conditioning	1
2.3	Operational amplifiers in instrumentation	2
2.4	Filters: low-pass, high-pass, band-pass	1
2.5	Analog to Digital Converters (ADC) and Digital to Analog Converters (DAC)	1
2.6	Sample & hold circuits	1
2.7	Multiplexers	1
2.8	Data Acquisition System architecture	1
MODULE III [9 hours]		
3.1	DVM, DMM, Function generators	2
3.2	CRO: construction,operation and measurements	2
3.3	Advanced CRO types	1
3.4	Introduction to Spectrum analyzers	1
3.5	Frequency counters and time interval measurements	1
3.6	Display technologies	2
MODULE IV [9 hours]		
4.1	Measurement of Temperature (thermistors, RTDs), Pressure, Displacement,Velocity	3
4.2	Biomedical Instrumentation Overview	2
4.3	Smart Sensors & Wireless Instrumentation	2
4.4	Case Studies	2
CO Assessment Questions		
CO-1	**3 Marks** 1. Define accuracy and precision with suitable examples. 2. What is resolution in a measurement system? 3. Differentiate between fidelity and lag in dynamic characteristics. **9 Marks** 1. Explain static and dynamic characteristics of a measurement system with examples. 2. Describe the functional elements of a basic measurement system.	

CO-2	**3 Marks** 1. Compare active and passive transducers with examples 2. Why is a band-pass filter used in signal conditioning? 3. What are the differences between AC and DC signal conditioning? **9 Marks** 1. Compare RTD, strain gauge, and piezoelectric transducers based on construction and applications. 2. With block diagrams, explain and analyze the role of op-amps and filters in signal conditioning systems. 3. Analyze different ADC types in terms of speed, resolution, and accuracy.
CO-3	**3 Marks** 1. How is a DMM used to measure resistance? 2. What is the function of a sample-and-hold circuit in a digital oscilloscope? 3. What are the advantages of a DSO over a CRO? **9 Marks** 1. Apply the working principle of CRO to measure voltage, time, and frequency of waveforms. 2. Describe how to use a function generator and frequency counter.
CO-4	**3 Marks** 1. What are smart sensors? Give one application. 2. How is body temperature monitored using RTDs in clinical instruments? 3. How is displacement measured using LVDT? **9 Marks** 1. Describe the application of instrumentation in biomedical systems such as ECG and patient monitoring. 2. Apply instrumentation techniques in designing a biomedical setup for real-time ECG monitoring. Include sensing, amplification, and display components.

Prepared by
Dr. J H Jensha Haennah, Asst. Prof, ECE

24ECE412	POWER ELECTRONICS	L	T	P	R	C	Year of Introduction
		3	0	0	0	3	2025

Preamble: This course aims to equip students with foundational knowledge and practical understanding of electronic measurement systems, focusing on transducers, signal conditioning, data acquisition systems, and the use of instruments for measuring physical parameters in engineering applications.

Prerequisite: Basic Electrical and Electronics Engineering, Network Theory, and Analog Circuits.

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

CO 1	Understand the characteristics of important semiconductor switches and the principles of drive circuits and snubber circuits for power electronics [**Understand]**
CO 2	Build diode rectifiers and controlled rectifiers and design DC-DC Switch mode converter **[Apply]**
CO 3	Analyze the principle of DC-AC switch mode Inverter **[Analyze]**
CO 4	Apply the principle of power electronics for various applications. [**Apply**]

CO - PO MAPPING											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	3	3									
CO2	3	3	3								
CO3	3	2	2								
CO4	3		2								

Assessment Pattern				
Bloom's Category	**Continuous Assessment Tools**			**End Semester Examination**
	Test1	**Test 2**	**Other tools**	
Remember	√	√	√	√
Understand	√	√	√	√
Apply	√	√	√	√
Analyze		√	√	√
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-R]	**Lecture [L]**				
	Attendance	**Assignment**	**Test-1**	**Test-2**	**Total Marks**
3-0-0-0	5	10	12.5	12.5	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	2.5 hours

End Semester Examination [ESE]: Pattern			
PATTERN	**PART A**	**PART B**	**ESE Marks**

PATTERN 1	8 Questions (2 Questions from each module), each question carries 3 marks Marks: (3x8 =24 marks)	2 questions will be given from each module, out of which 1 should be answered. Each question can have a maximum of two sub-divisions. Each question carries 9 marks. Marks: (9x4 = 36 marks)	60

SYLLABUS

MODULE I: Measurement Fundamentals and Characteristics (9 hours)

Power diodes, Power BJT, Power MOSFET and IGBT - static and dynamic characteristics, SCR and GTO. BJT and MOSFET drive circuits, Snubber circuits, Three phase diode bridge rectifiers, Single phase and three phase controlled rectifiers.

Self- Study: 14 Hrs

1. Why are MOSFETs preferred over BJTs at high frequencies?
2. What makes IGBTs suitable for high voltage and power applications?
3. How does the snubber circuit improve device reliability?
4. How does firing angle affect the output voltage in controlled rectifiers?
5. Why are three-phase rectifiers preferred in industrial applications?

MODULE II: Signal Conditioning and Data Acquisition (9 hours)

Buck, Boost and Buck-boost DC-DC converters, Waveforms and expression of DC-DC converters for output voltage, voltage and current ripple under continuous conduction mode. (No derivation required) Isolated converters: Flyback, Forward, Push Pull, Half bridge and Full bridge converters – Waveforms and governing equations (No derivation required)

Self- Study: 13 Hrs

1. Draw switching waveforms (switch voltage, current, inductor current, diode current) for Buck, Boost, and Buck-Boost converters in CCM.
   How does changing the duty cycle DDD affect the output voltage in each converter?
2. Why are isolated converters used instead of non-isolated in some applications?
3. What role does the transformer play in isolated converters?
4. How does the switching frequency influence voltage and current ripples?

MODULE III: Electronic Measurement Instruments(9 hours)

Inverter topologies, Driven Inverters: Push-Pull, Half bridge and Full bridge configurations, Three phase inverter, Pulse width modulation

Self- Study: 13 Hrs

1. How does a full-bridge inverter produce AC from a DC supply?
2. What is the advantage of using PWM over simple square wave switching?
3. How does SPWM improve inverter output quality?
4. How do three-phase inverters differ from single-phase in terms of switching control?

MODULE IV: Applications of Instrumentation (9 hours)

DC Motor Drives, Induction Motor Drives, Residential and Industrial applications.

Self- Study: 14 Hrs

1. Why are induction motors more common in industrial settings?
2. When is a DC motor drive still preferred today?
3. What are the benefits of using variable frequency drives (VFDs)?
4. How does torque control differ between DC and induction motors?
5. Learn real-world residential and industrial applications of motor drives.
6. Understand the role of power electronic converters in motor control.

Textbooks

1. Umanand L, "Power Electronics: Essentials & Applications", Wiley India, 2015
2. Ned Mohan, Tore M Undeland, William P Robbins., "Power Electronics: Converters, Applications, and Design"., Wiley India Pvt. Ltd, 3/e, 2015

Reference books

1. Muhammad H. Rashid., "Power Electronics : Circuits, Devices, and Applications", Pearson Education India, 4/e, 2014.
2. Daniel W. Hart, Power Electronics, McGraw Hill, 2011.
3. Ned Mohan, Tore M Undeland, William P. Robbins "Power Electronics Converters, Applications, and Design" Wiley India Third Edition

NPTEL/SWAYAM Courses for reference:

1. **NPTEL:: FUNDAMENTAL OF POWER ELECTRONICS :: IISc Bangalore**
   https://archive.nptel.ac.in/courses/108/101/108101126/
2. **NPTEL:: Power Electronics::IIT BOMBAY**
   NPTEL :: Electrical Engineering - Power Electronics
3. **NPTEL::POWER ELECTRONICS:: IIT DELHI**
   https://archive.nptel.ac.in/courses/108/102/108102145/

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours [36 hours]
MODULE 1 [9 hours]		
1.1	Power diodes, Power BJT, Power MOSFET and IGBT - static and dynamic characteristics	1
1.2	SCR and GTO. BJT and MOSFET drive circuits	2
1.3	Snubber circuits,	1
1.4	Three phase diode bridge rectifiers	2
1.5	Three phase diode bridge rectifiers, Single phase and three phase controlled rectifiers.	3
MODULE II [9 hours]		
2.1	Buck, Boost and Buck-boost DC-DC converters	2
2.2	Waveforms and expression of DC-DC converters for output voltage, voltage and current ripple under continuous conduction mode. (No derivation required)	3
2.3	Isolated converters: Flyback, Forward, Push Pull,	2
2.4	Half bridge and Full bridge converters – Waveforms and governing equations (No derivation required)	2
MODULE III [9 hours]		
3.1	Inverter topologies	2
3.2	Driven Inverters : Push-Pull, Half bridge and Full bridge configurations,	3
3.3	Three phase inverter	2
3.4	Pulse width modulation	2
MODULE IV [9 hours]		
4.1	DC Motor Drives	3
4.2	Induction Motor Drives	3
4.3	Residential and Industrial applications.	3
CO Assessment Questions		
CO-1	1. Illustrate the static and dynamic characteristics, Power BJT, Power MOSFET and IGBT. 2. Design the gate drive circuits for Power MOSFET. 3. Model and simulate power semiconductor switches.	
CO-2	1. Explain the operation of controlled rectifiers and the effect of various loads on the rectifier function 2. Model and simulate diode rectifiers and controlled rectifiers for	

	various loads 3. Model and simulate non-isolated and isolated DC-DC Switch-Mode converters
CO-3	1. Understand the different types of inverters 2. Construct Driven Inverters for given specifications. 3. Model and simulate Driven Inverters
CO-4	1. Illustrate the principle of Adjustable-speed DC drive. 2. Explain the principle of Variable frequency PWM-VSI Induction Motor drives 3. Give at least two applications of power electronic circuits for residential applications. 4. Explain at least two applications of power electronic circuits for industrial applications

Prepared by
Siji Joseph, Asst. Prof, ECE

24ECE413	**SENSORS AND ACTUATORS**	**L**	**T**	**P**	**R**	**C**	**Year of Introduction**
		3	**0**	**0**	**0**	**3**	**2024**

Preamble: The course enables the students to understand the fundamental principles, working, and applications of sensors and actuators. It covers various sensor types, actuator mechanisms, signal processing, interfacing, and their integration in modern systems like IoT and robotics.

Prerequisite: Basic knowledge of physics, and electronic circuits

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

CO 1	Explain the fundamental concepts of sensors, actuators, and their classifications. [**Understand**]
CO 2	Analyze the working principles and characteristics of various sensors and actuators. [**Analyze**]
CO 3	Apply signal conditioning and interfacing techniques for integrating sensors and actuators into systems. [**Apply**]
CO 4	Design sensor-actuator systems for specific applications in Embedded Systems. [**Create**]

CO - PO MAPPING

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	√	√		√
Understand	√	√		√
Apply	√	√		√
Analyze		√	√	
Evaluate			√	
Create			√	

Mark Distribution of CIA

Course Structure [L-T-P-R]	Lecture [L]				
	Attendance	Assignment & Project	Test-1	Test-2	Total Marks
3-0-0-0	5	10	12.5	12.5	40

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	2.5 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	8 Questions (2 Questions from each module), each question carries 3 marks Marks: (3x8 =24 marks)	2 questions will be given from each module, out of which 1 should be answered. Each question can have a maximum of two sub-divisions. Each question carries 9 marks.	60

		Marks: (9x4 = 36 marks)	

SYLLABUS

MODULE I: Introduction to Sensors and Actuators(9 hours)

Introduction to Sensors and Actuators: Importance in engineering systems, Definitions, and Functions. **Classification of Sensors**: Active vs. Passive, Analog vs. Digital, Contact vs. Non-contact. **Characteristics of Sensors**: Sensitivity, Accuracy, Resolution, Linearity, Range, Drift, and Hysteresis. **Introduction to Actuators**: Definitions, classification, and their importance in control systems. **Basic Mechatronics Overview**.

Self-Study Activities (14 hrs):

- **Reading Task**: Prepare a comparative chart on sensor classifications (active/passive, analog/digital, contact/non-contact) with examples for each.
- **Data Exploration**: Review technical datasheets of 3 sensors (e.g., LM35, LDR, Ultrasonic) and document their characteristics: sensitivity, accuracy, resolution, and hysteresis.
- **Application Case Study**: Choose a mechatronic system (e.g., automated door, robotic gripper, drone) and identify all its sensors and actuators.
- **Hands-on Task**: Use a simulation tool (Tinkercad or Proteus) to simulate a simple sensor-actuator loop (e.g., LDR + relay + motor).
- **Team Presentation**: In groups, analyze how contact and non-contact sensors are used in automotive systems (e.g., proximity sensor, brake pedal sensor).
- **Video Analysis**: Watch NPTEL or MIT OCW videos on mechatronics or sensors and summarize key takeaways with diagrams.

MODULE II: Sensor Technologies and Working Principles (9 hours)

Working Principles of Sensors: Resistive, Capacitive, and Inductive sensors. **Thermal Sensors**: RTDs, Thermocouples, Thermistors. **Optical Sensors**: Photodiodes, LDRs, Fiber-optic sensors. **Chemical Sensors**: Gas sensors, Humidity sensors, pH sensors. **MEMS Sensors**: Accelerometers, Gyroscopes, Pressure sensors. **Biosensors**: Principles and examples. **Environmental Sensors**: Air and water quality monitoring sensors.

Self-Study Activities (13 hrs):

- **Sensor Deep-Dive**: For each category (thermal, optical, chemical, MEMS, biosensors), choose one sensor and:
  - Read its datasheet
  - Explain its working principle and application
  - Present a real-world device that uses it
- **Lab Work**: Build Arduino circuits for any two of the following:
  - LDR (light detection)
  - DHT11 (humidity & temperature)
  - MPU6050 (accelerometer & gyro)
- **Simulation Task**: Simulate or analyze waveforms from a thermistor and RTD under changing temperatures.
- **Device Analysis**: Open up a smart gadget (e.g., smartwatch, fitness band, smartphone) and identify the types of sensors it contains.
- **Mini-Research Report**: Investigate how fiber-optic sensors or biosensors are used in healthcare and summarize your findings.
- **Group Comparison**: Compare MEMS vs traditional sensors in terms of size, cost, power consumption, and accuracy.

MODULE III: Actuator Technologies and Working Principles (9 hours)

Types of Actuators: Electromechanical (DC/AC Motors, Stepper Motors, Servo Motors), Hydraulic and Pneumatic Actuators. **Smart Actuators**: Shape Memory Alloys (SMA), Piezoelectric Actuators, and Electroactive Polymers. **Rotary and Linear Actuators**: Working principles and characteristics. **Applications**: Robotics, Medical Devices, and Industrial Automation. **Control Systems for Actuators**: Overview of feedback control.

Self-Study Activities (13 hrs):

- **Actuator Functionality Demo**: Build small demos with Arduino to control:
  - Servo motor (angular control)
  - DC motor (PWM speed control)
  - Stepper motor (angle step control)
- **Research-Based Design**: Choose an application (e.g., robotic arm, ventilator, or conveyor belt), and propose an actuator configuration (type, control method, power source).
- **Real-World Investigation**: Analyze how smart actuators (e.g., piezoelectric or SMA) are used in aerospace or medical devices (e.g., microgrippers).
- **Troubleshooting Task**: Simulate a stepper or servo circuit and deliberately introduce errors (e.g., reverse power, bad signal) to identify troubleshooting techniques.
- **Video Summary**: Watch tutorials on pneumatic/hydraulic actuators in

industrial robotics and create a poster showing pros and cons of each.

- **Compare & Contrast**: Summarize differences between rotary vs linear actuators in terms of working principles, applications, and response time.

MODULE IV: Signal Processing, Interfacing, and Applications (9 hours)

Signal Conditioning: Amplifiers, Filters, ADC/DAC, and Calibration Techniques. **Sensor Interfacing**: Interfacing with Arduino. **Communication Protocols**: I2C, SPI, and UART. **Applications in Emerging Technologies**: IoT systems (Smart Homes, Wearables), Automotive Applications, Biomedical Devices, and Environmental Monitoring.

Self-Study Activities (14 hrs):

- **Hands-on Sensor Interfacing**:
  - Use Arduino to read analog signals (e.g., from LM35)
  - Apply basic filtering in software (e.g., moving average)
  - Output via serial plotter or LCD
- **Protocol Lab**:
  - Interface an I2C sensor (e.g., BMP180)
  - Interface an SPI module (e.g., MFRC522 RFID)
  - Compare protocols: speed, wiring, data capacity
- **Simulation Task**: Use LTspice or Falstad to simulate an amplifier and filter chain, analyzing gain and frequency response.
- **Mini-Project**: Design a data acquisition system with calibration and interfacing for any environmental application (e.g., air quality sensor).
- **System Design Task**: Sketch and explain an IoT-based health monitoring system integrating ADC, sensor modules, and communication.
- **Case Study**: Analyze a real wearable device (e.g., Fitbit, Apple Watch) focusing on how signal conditioning and protocols are used.

Textbooks

1. **S. Nihtianov, A. Luque**, *Smart Sensors and MEMS: Intelligent Devices and Microsystems for Industrial Applications*, 2nd Edition, Elsevier, 2018.
2. **Ramón Pallás-Areny, John G. Webster**, *Sensors and Signal Conditioning*, 3rd Edition, Wiley, 2022.
3. **Clarence W. de Silva**, *Sensors and Actuators: Engineering System Instrumentation*, CRC Press, 2nd Edition, 2016.

Reference books

1. **Jacob Fraden**, *Handbook of Modern Sensors: Physics, Designs, and Applications*, 5th Edition, Springer, 2022.
2. **Robert H. Bishop**, *The Mechatronics Handbook: Sensors and Actuators Section*, CRC Press, 2nd Edition, 2018.
3. **E. A. Parr**, *Sensors and Actuators in Mechatronics: Design and Applications*, Elsevier, 2021.

Additional tools for self learning
Tinkercad Circuits (Autodesk – Free Browser-based Tool)
https://www.tinkercad.com/circuits
LTspice (Analog Devices – Free SPICE Simulator)
https://www.analog.com/en/design-center/design-tools-and-calculators/ltspice-simulator.html
Simscape Onramp (MathWorks)
https://matlabacademy.mathworks.com/details/simscape-onramp/simscape
Circuit Simulation Onramp (MathWorks)
https://matlabacademy.mathworks.com/details/simulink-onramp/simulink

NPTEL/SWAYAM Courses for reference:
Introduction to Sensors and Actuators SWAYAM Link:
https://onlinecourses.nptel.ac.in/noc21_ee32/preview
Embedded Sensing, Actuation and Interfacing Systems SWAYAM Link:
https://onlinecourses.nptel.ac.in/noc24_ee68/preview

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours [36 hours]
	MODULE 1 [9 hours]	
1.1	Importance in engineering systems, Definitions, and Functions.	1
1.2	**Classification of Sensors**: Active vs. Passive, Analog vs. Digital, Contact vs. Non-contact.	1
1.3	**Characteristics of Sensors**: Sensitivity, Accuracy, Resolution	1
1.4	Linearity, Range, Drift, and Hysteresis.	2
1.5	**Introduction to Actuators**: Definitions, classification	1
1.6	Importance of Actuators in control systems.	1
1.7	Basic Mechatronics Overview.	2
	MODULE II [9 hours]	
2.1	**Working Principles of Sensors**: Resistive, Capacitive, and Inductive sensors.	1
2.2	**Thermal Sensors**: RTDs, Thermocouples, Thermistors.	2
2.3	**Optical Sensors**: Photodiodes, LDRs, Fiber-optic sensors.	1
2.4	**Chemical Sensors**: Gas sensors, Humidity sensors, pH sensors.	1
2.5	**MEMS Sensors**: Accelerometers, Gyroscopes, Pressure sensors.	2

2.6	**Biosensors**: Principles and examples. **Environmental Sensors**: Air and water quality monitoring sensors.	2
MODULE III [9 hours]		
3.1	**Types of Actuators**: Electromechanical (DC/AC Motors, Stepper Motors, Servo Motors)	1
3.2	Hydraulic and Pneumatic Actuators.	1
3.3	**Smart Actuators**: Shape Memory Alloys (SMA)	1
3.4	Piezoelectric Actuators, and Electroactive Polymers.	2
3.5	**Rotary and Linear Actuators**: Working principles and characteristics.	1
3.6	**Applications**: Robotics, Medical Devices, and Industrial Automation.	2
3.7	**Control Systems for Actuators**: Overview of feedback control.	1
MODULE IV [9 hours]		
4.1	**Signal Conditioning**: Amplifiers, Filters, ADC/DAC, and Calibration Techniques.	2
4.2	**Sensor Interfacing**: Interfacing with microcontrollers and microprocessors (e.g., Arduino, STM32, Raspberry Pi).	3
4.3	**Communication Protocols**: I2C, SPI, and UART.	1
4.4	**Applications in Emerging Technologies**: IoT systems (Smart Homes, Wearables)	1
4.5	Automotive Applications, Biomedical Devices	1
4.6	Environmental Monitoring. **AI and Machine Learning in Sensor Systems**.	1
CO Assessment Questions		
CO-1	1. Define a sensor and an actuator. Explain the fundamental difference between them with suitable examples. 2. Discuss the various classifications of sensors based on their working principles. Provide examples for each classification. 3. Explain the concept of transduction in sensors. Illustrate with examples of a sensor that uses a mechanical transducer and one that uses an electrical transducer.	
CO-2	1. Analyze the working principle of a capacitive sensor. Compare its characteristics with that of a resistive sensor. 2. Explain the working of a piezoelectric actuator. Discuss its advantages and limitations compared to hydraulic actuators. 3. Compare the operation of a temperature sensor (e.g., thermocouple) and a pressure sensor (e.g., strain gauge). Discuss their sensitivity, range, and typical applications.	

CO-3	1. Describe the steps involved in signal conditioning for a sensor output that is not in the desired range for an analog-to-digital converter. Provide examples of signal conditioning circuits. 2. Explain the role of amplifiers in sensor signal conditioning. How would you interface a sensor with a microcontroller for processing? 3. Given a temperature sensor with a linear output, outline the signal conditioning steps and interfacing with a microcontroller to display temperature on an LCD.
CO-4	1. Design a sensor-actuator system for a home automation application using a temperature sensor and a fan actuator. Explain the system's functionality and components. 2. Design a robotic arm system where sensors (e.g., proximity sensors, accelerometers) and actuators (e.g., servos, motors) work together to achieve motion control. 3. Create an IoT-based monitoring system that uses environmental sensors (e.g., air quality, humidity) and actuators (e.g., solenoid valves) for agricultural automation. Describe the key components and data flow.
Assignment Questions	
1	Using an LDR (Light Dependent Resistor) and a relay-controlled bulb, design a system that automatically turns ON the light when ambient light falls below a certain threshold. Draw the circuit diagram, list the components used, explain the logic, and suggest improvements using digital light sensors (e.g., TSL2561 with I2C).
2	Develop a system where an ultrasonic sensor detects a person approaching a door and a servo motor opens the door automatically. Explain the interfacing with a microcontroller (such as Arduino), show the control logic (flowchart or pseudocode), and list hardware and software requirements.
3	Create a basic IoT system where a soil moisture sensor monitors soil dryness and automatically controls a water pump (via a relay module). The system should send the status to a smartphone using Wi-Fi (e.g., using NodeMCU or ESP32). Describe the setup, wiring, control algorithm, and show sample output readings.

Prepared by
Dr. Vishnu Rajan, Associate Professor,
Department of ECE

Reviewed by
Dr. Dhaneesh Chandran
SITAR, DRDO Bangalore


EDUCATION IS DEDICATION

24ECE414	MACHINE LEARNING	L	T	P	R	C	Year of Introduction
		3	0	0	0	3	2024

Preamble: This course aims to provide a comprehensive foundation in machine learning, starting from basic concepts to advanced techniques. The course is designed to engage students in a deep understanding of machine learning algorithms. Throughout the course, learners will develop the critical skills necessary to design, implement, and evaluate machine learning models for a wide range of real-world problems.

Prerequisite: Linear algebra, Probability, and statistics

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

CO 1	Understand the types of machine learning algorithms and its performance parameters.[**Understand**]
CO 2	Apply supervised learning algorithms and dimensionality reduction to various datasets.[**Apply**]
CO 3	Apply various unsupervised learning algorithms to various datasets.[**Apply**]
CO 4	Understand the key concepts in artificial neural networks **.[Understand**]

CO - PO MAPPING

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	√	√	√	√
Understand	√	√	√	√
Apply	√	√	√	√
Analyze				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-R]	Lecture [L]				
	Attendance	Assignment	Test-1	Test-2	Total Marks
4-0-0-0	5	10	12.5	12.5	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	2.5 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	8 Questions (2 Questions from each module), each question carries 3 marks Marks: (3x8 =24 marks)	2 questions will be given from each module, out of which 1 should be answered. Each question can have a maximum of two sub-divisions. Each question carries 9 marks. Marks: (9x4 = 36 marks)	60

SYLLABUS

MODULE I: Introduction to Machine learning(9 hours)

Introduction-Supervised, unsupervised machine learning techniques, Instance-Based vs Model-Based Learning, Machine Learning models, Hyper parameters, regularization, Training - Batch and Online Learning, Challenges of Machine Learning: Data Issues-Quality, Relevancy, Over fitting, under fitting. Bias, variance, Performance metrics: Accuracy, Recall, Precision, ROC curve

Self study (15 hrs)

1. For a voice recognition system on a mobile phone, would instance-based or model-based learning be more suitable? Justify your choice.
2. A company receives customer feedback daily. How would you apply online learning to update your model continuously?
3. In training a movie recommendation system, why might you prefer batch learning over online learning?
4. A disease prediction model gives many false negatives. Which metric would you focus on improving—accuracy, recall, or precision? Why?
5. Use Python (scikit-learn or a simulation) to: Train a model using batch learning, simulate online learning with incremental training
   Compare performance and training time.
6. Download a public dataset (e.g., Titanic, Iris) and perform: Class imbalance analysis

MODULE II: Supervised Learning (9 hours)

Regression: linear regression, logistic regression error functions in regression, MSE, L1, L2, Cross entropy multivariate regression. Classification: Naive Bayes classifier, Support Vector machines-Linear and nonlinear SVMs, Decision trees -random forests, Ensemble methods: boosting, bagging.

Self study (15 hrs)

1. You are given a dataset of house prices with features like area and number of rooms. How would you use linear regression to predict prices?
2. A regression model is underperforming. How would you decide whether to use Mean Squared Error (MSE) or Mean Absolute Error (L1) as the loss function?
3. You want to classify news articles into categories (e.g., sports, politics, entertainment). How would you apply the Naive Bayes algorithm?
4. Derive the formulas for MSE, MAE, L1, and L2 losses. Plot their shapes using Python (e.g., Matplotlib)
5. Use a dataset like Boston Housing (or any multivariate dataset). Train a multivariate linear regression model. Visualize the impact of at least two independent variables
6. Train an SVM with a linear kernel and a nonlinear (RBF) kernel

MODULE III: Unsupervised Learning(9 hours)

Unsupervised learning: Clustering-K-means, High, Hierarchical clustering, criterion functions for clustering, proximity measures, Euclidean, Manhattan, Minkowski Distances, Cosine Similarity. Dimensionality Reduction- Principal component analysis, PCA kernel, Reinforcement Learning: Agent based learning, Q-learning, Introduction to HMM models

Self study (15 hrs):

1. Explain how changing the number of clusters (K) in K-means affects clustering performance with a real-world example
2. A student's performance over weeks is observed as "good" or "bad," but the actual mental state (motivated/unmotivated) is hidden. How would you model this using HMM?
3. A cleaning robot learns the optimal path to cover a room. How would you apply agent-based learning to model this behavior?
4. You are building a machine learning model on a dataset with 100 features. How would you apply PCA to reduce complexity while preserving most of the information?
5. Apply K-means to a dataset (e.g., Iris or synthetic blobs) using scikit-learn.Visualize clusters (2D plot), analyze the role of centroids, and experiment with different k values
6. Create a small dataset of 2D points. Compute distances between points using: **Euclidean**, **Manhattan**. Visualize how the measures differ and discuss best-suited cases for each

MODULE IV: Artificial neural networks(9 hours)

Introduction to Artificial Neural Networks: Biological Neuron, Perceptron, Training, limitations, XOR problem, Multilayer perceptron, Gradient based learning, stochastic gradient descent, Activation Functions-Sigmoid, ReLU, tanh. Back propagation- Chain rule, Regularization- L1, L2

Self study (15 hrs)

1. Develop a neural network to recognize handwritten digits. Describe how you would apply a multilayer perceptron to this task.
2. Train a deep neural network for image classification. Compare the perfirmance with activation functions ReLU, sigmoid and tanh?
3. Design a two-layer neural network to solve the XOR problem. What type of activation functions would you use and why?
4. Write code (Python) for a single-layer perceptron. Train it to learn AND and OR gates. Plot output vs input. Discuss why it fails on XOR
5. Use scikit-learn or Keras to train an MLP for digit or letter recognition (e.g., MNIST or sklearn digits dataset). Experiment with different numbers of hidden layers and neurons
6. Create a visual concept map showing: Loss surface, Gradient vector, Role of learning rate

Textbooks

1. Machine learning for absolute beginners, Oliver Theobald, Second edition
2. Hands-on Machine learning with Sc-kit Learn Keras and Tensorflow (module 1), Aurelien Geron, Oreilly, Second Edition, 2019
3. Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction (Adaptive Computation and Machine Learning series) 2nd edition, A Bradford Book; 2018.
4. Introduction to Machine learning with Python, Andreas C. Müller & Sarah Guido, O'Reilly 2017

Reference books

1. Magnus Ekman,Learning Deep learning, Addison -Wesley ,2022
2. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006
3. Charu C. Aggarwal, Data Classification Algorithms and Applications, CRC Press, 2014
4. Pattern Recognition, Theodoridis, S. and Koutroumbas, K., Academic Press, San Diego,. 2003

NPTEL/SWAYAM Courses for reference:

1. NPTEL :: Introduction to Machine Learning- IITM
   https://onlinecourses.nptel.ac.in/noc25_cs46/preview
2. NPTEL :: Machine Learning and Deep Learning - Fundamentals and Applications
   https://onlinecourses.nptel.ac.in/noc24_ee146/preview
3. NPTEL ::Introduction to Machine Learning- IITKGP
   https://onlinecourses.nptel.ac.in/noc24_cs81/preview
4. NPTEL ::Pattern Recognition and Application
   https://onlinecourses.nptel.ac.in/noc19_ee56/preview

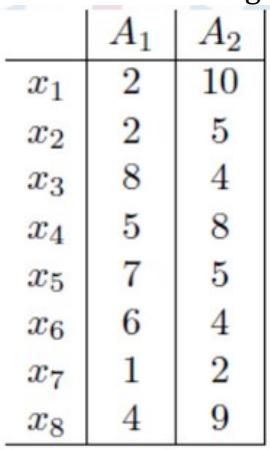
No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours [36 hours]
MODULE 1 [9 hours]		
1.1	Introduction-Supervised, unsupervised machine learning techniques, Instance-Based vs Model-Based Learning	2
1.2	Machine Learning models, Hyper parameters, regularization, Training - Batch and Online Learning	2
1.3	Challenges of Machine Learning: Data Issues-Quality, Relevancy, Over fitting, under fitting. Bias, variance	2
1.4	Performance metrics: Accuracy, Recall, Precision, ROC curve	3
MODULE II [9 hours]		
2.1	Regression: linear regression, logistic regression, error functions in regression, MSE, L1, L2, Cross entropy multivariate regression.	3
2.2	Classification: Naive Bayes classifier, Support Vector machines	2
2.3	Decision trees -random forests, Ensemble methods: boosting, bagging.	2
2.4	Dimensionality Reduction- Principal component analysis, PCA kernel	2
MODULE III [9 hours]		
3.1	Unsupervised learning: Clustering-K-means, High, Hierarchical clustering	3
3.2	Criterion functions for clustering, proximity measures, Euclidean, Manhattan, Minkowski Distances, Cosine Similarity	2
3.3	Reinforcement Learning: Agent based learning, Q-learning	2
3.4	Introduction to HMM models	2
MODULE IV [9 hours]		
4.1	Introduction to Artificial Neural Networks: Biological Neuron, Perceptron, Training, limitations, XOR problem	3
4.2	Multilayer perceptron, Gradient based learning, stochastic gradient descent	2
4.3	Activation Functions-Sigmoid, ReLU, tanh	2
4.4	Back propagation- Chain rule, Regularization- L1, L2	2
CO Assessment Questions		
CO-1	1. Discuss any four examples of machine learning applications. 2. Differentiate between supervised and unsupervised training. Explain with suitable examples. 3. Explain the performance metrics of machine learning algorithms. 4. Suppose 10000 patients get tested for flu; out of them, 9000 are actually healthy and 1000 are actually sick. For the sick people, a	

	test was positive for 620 and negative for 380. For the healthy people, the same test was positive for 180 and negative for 8820. Construct a confusion matrix for the data and compute the precision and recall for the data.
CO-2	1. The following data set contains factors that determine whether tennis is played or not. Using Naive Bayes classifier, find the play prediction for the day **<Sunny, Cool, High, Strong>**

DAY	OUTLOOK	TEMP	HUMIDITY	WIND	PLAY
Day 1	Sunny	Hot	High	Weak	NO
Day 2	Sunny	Hot	High	Strong	NO
Day 3	Overcast	Hot	High	Weak	YES
Day 4	Rain	Mild	High	Weak	YES
Day 5	Rain	Cool	Normal	Weak	YES
Day 6	Rain	Cool	Normal	Strong	NO
Day 7	Overcast	Cool	Normal	Strong	YES
Day 8	Sunny	Mild	High	Weak	NO
Day 9	Sunny	Cool	Normal	Weak	YES
Day 10	Rain	Mild	Normal	Weak	YES
Day 11	Sunny	Mild	Normal	Strong	YES
Day 12	Overcast	Mild	High	Strong	YES
Day 13	Overcast	Hot	Normal	Weak	YES
Day 14	Rain	Mild	High	Strong	NO

2. Consider the training data in the following table where Play is a class attribute. In the table, the Humidity attribute has values “L” (for low) or “H” (for high), Sunny has values “Y” (for yes) or “N” (for no), Wind has values “S” (for strong) or “W” (for weak), and Play has values “Yes” or “No”.
   What is class label for the following day (Humidity=L, Sunny=N, Wind=W), according to naïve Bayesian classification?

Humidity	Sunny	Wind	Play
L	N	S	No
H	N	W	Yes
H	Y	S	Yes
H	N	W	Yes
L	Y	S	No

<table>
<tr><td></td><td>3. Discuss the necessity of dimensionality reduction in machine learning
4. Explain the procedure for the computation of the principal components of the data.</td></tr>
<tr><td>CO-3</td><td>1. Explain k-means clustering algorithm with an example
2. Differentiate Euclidean, Manhattan, Minkowski Distances
3. Explain Reinforcement learning
4. Cluster the eight points shown below using k-means
 
Assume that k = 3 and that initially the points are assigned to clusters as follows: C1 = {x1, x2, x3}, C2 = {x4, x5, x6}, C3 = {x7, x8}. Apply the k-means algorithm until convergence, using the Manhattan distance.</td></tr>
<tr><td>CO-4</td><td>1. Calculate the output y of a three input neuron with bias. The input feature vector is (x1, x2, x3) = (0.8,0.6,0.4) and weight values are [w1,w2,w3, b]=[0.2, 0.1, -0.3, 0.35]. Use binary Sigmoid function as activation function.
2. Explain back propagation algorithm
3. ReLU activation functions are most used in neural networks instead of the tanh activation function. Why?
4. Explain stochastic gradient descent algorithm</td></tr>
</table>

	A_1	A_2
x_1	2	10
x_2	2	5
x_3	8	4
x_4	5	8
x_5	7	5
x_6	6	4
x_7	1	2
x_8	4	9

Prepared by
Binet Rose Devassy, ECE Department

24ECE415	Digital Systems and VLSI Design	L	T	P	R	C	Year of Introduction
		3	0	0	0	3	2024

Preamble: This course introduces fundamental concepts and design methodologies in digital systems, with a focus on both synchronous and asynchronous sequential circuits. It also explores the principles of VLSI design, covering physical layout issues, signal integrity, and design-for-test techniques. The integration of fault modeling, testing algorithms, and ASIC design considerations prepares students for modern digital system design and hardware testing.

Prerequisite: 24ECR304-Logic Circuit Design

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

CO 1	Analyze and design Clocked Synchronous Sequential Networks and represent them using ASM charts. **[Analyze]**
CO 2	Demonstrate the ability to design, analyze, and optimize asynchronous sequential circuits (ASCs) for digital systems. **[Analyze/Design]**
CO 3	Identify hazards in digital circuits and apply test algorithms for fault detection and correction.**[Apply]**
CO 4	Analyze the principles of Design for Test (DFT) and apply foundational concepts of VLSI physical design, including fabrication, interconnects, and signal integrity considerations. **[Analyze/Apply]**

CO - PO MAPPING

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember				
Understand	√	√	√	√
Apply	√	√	√	√
Analyze	√	√	√	√
Evaluate				
Create				

Mark Distribution of CIA

	Lecture [L]				
Course Structure [L-T-P-R]	**Attendance**	**Assignment**	**Test-1**	**Test-2**	**Total Marks**

3-0-0-0	5	10	12.5	12.5	40

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	2.5 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	8 Questions (2 Questions from each module), each question carries 3 marks Marks: (3x8 =24 marks)	2 questions will be given from each module, out of which 1 should be answered. Each question can have a maximum of two sub-divisions. Each question carries 9 marks. Marks: (9x4 = 36 marks)	60

SYLLABUS

MODULE I (9 hrs)

Clocked Synchronous Networks, Analysis of Clocked Synchronous Sequential Networks (CSSN), Mealy machine, Moore machine, Modelling of CSSN, State assignment and reduction, Design of CSSN, ASM Chart and its realization.

Self-Study (13 hrs):

1. Explore real-time applications of Mealy and Moore machines in control systems.
2. Study techniques for state minimization and state assignment in FSMs.
3. Analyze and draw ASM charts for simple digital systems (e.g., elevator controller, sequence detector).
4. Simulate CSSNs using tools like Logisim or Multisim.
5. Review case studies where synchronous FSMs are used in embedded systems.

MODULE II (9 hrs)

Asynchronous Sequential Circuits, Analysis of Asynchronous Sequential Circuits (ASC), Flow table reduction, Races in ASC, State assignment problem and the transition table, Design of Asynchronous Sequential Circuits, Design of ALU.

Self-Study (14 hrs):

1. Compare synchronous vs asynchronous circuit behavior using timing diagrams.
2. Study methods to avoid races and hazards in ASCs.
3. Review design techniques for stable and hazard-free asynchronous circuits.
4. Examine the design of an ALU using basic logic gates and control flow.

MODULE III (9 hrs)

Reliability and Fault Tolerance**,** Hazards – static and dynamic hazards in combinational networks, Essential Hazards, Design of Hazard free circuits, Data synchronizers, Mixed operating mode asynchronous circuits, Practical issues- clock skew and jitter, Synchronous and asynchronous inputs, Flip-Flops and Simple Flip Flop Applications, Switch debouncer. Faults, Fault table method – path sensitization method – Boolean difference method, Kohavi algorithm.

Self-Study (13 hrs):

1. Create a fault table for a 3-input circuit.
2. Practice adding redundant terms to eliminate hazards.
3. Identify circuits where asynchronous inputs create problems.
4. Read application Notes by Xilinx or Intel on clock domain crossing (CDC)**.**
5. Use logic simulators like Logisim or DigitalS to simulate glitches.
6. Read: *Morris Mano – Digital Design* (Chapter on Hazards).

MODULE IV (9 hrs)

Design for Test: Automatic test pattern generation, Built in Self-Test (BIST)
Basic Concepts for Physical Design: IC Fabrication, FEOL, BEOL, Interconnects and Parasitics, Signal Integrity, Antenna Effect, Electro migration, LEF files.

Self-Study (14 hrs):

1. Study BIST architecture (Test Pattern Generator, Output Response Analyzer).
2. Read papers/articles on crosstalk**,** ground bounce**,** and reflection.
3. Watch videos from MIT OpenCourseWare or Intel Process Technology**.**
4. Understand D-algorithm and random test generation.
5. Explore example LEF/DEF files from open-source tools like OpenROAD**.**

Reference books

1. Donald G. Givone, *Digital Principles & Design*, McGraw Hill Education, 2017.
2. John F. Wakerly, *Digital Design: Principles and Practices*, Pearson India, 4th Edition, 2008.
3. John M. Yarbrough, *Digital Logic Applications and Design*, Cengage Learning India, 1st Edition, 2006.

4. M. Morris Mano and Michel D. Ciletti, *Digital Design: With an Introduction to the Verilog HDL, VHDL, and SystemVerilog*, Pearson, 6th Edition, 2017.

Additional Tools for Self-Learning (Recommended)

- www.edaplayground.com

NPTEL/SWAYAM Courses for reference:

1. NPTEL :: Digital Circuits and Systems (IIT Madras) https://archive.nptel.ac.in/courses/117/106/117106086/
2. NPTEL :: Digital System Design(IIT Ropar) nptel.ac.in/courses/108106177

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours [36 hours]
	MODULE 1 [9 hours]	
1.1	Clocked Synchronous Networks, Analysis of Clocked Synchronous Sequential Networks (CSSN)	2
1.2	Mealy machine, Moore machine	2
1.3	Modelling of CSSN, State assignment and reduction	3
1.4	Design of CSSN, ASM Chart and its realization.	2
	MODULE II [9 hours]	
2.1	Asynchronous Sequential Circuits, Analysis of Asynchronous Sequential Circuits (ASC),	2
2.2	Flow table reduction, Races in ASC	2
2.3	State assignment problem and the transition table	2
2.4	Design of Asynchronous Sequential Circuits.	2
2.5	Design of ALU.	1
	MODULE III [9 hours]	
3.1	Reliability and Fault Tolerance,Hazards – static and dynamic hazards in combinational networks, Essential Hazards, Design of Hazard free circuits	2
3.2	Data synchronizers, Mixed operating mode asynchronous circuits	2
3.3	Practical issues- clock skew and jitter, Synchronous and asynchronous inputs, Flip-Flops and Simple Flip Flop Applications, Switch debouncer	3
3.4	Faults, Fault table method – path sensitization method –	2

	Boolean difference method, Kohavi algorithm.	
MODULE IV [9 hours]		
4.1	Design for Test: Automatic test pattern generation, Built in Self-Test (BIST)	3
4.2	Basic Concepts for Physical Design: IC Fabrication, FEOL, BEOL, Interconnects and Parasitics.	3
4.3	Signal Integrity, Antenna Effect, Electro migration, LEF files.	3

CO Assessment Questions	
CO-1	1. Compare the state transitions of Mealy and Moore machines using a timing diagram. 2. Given a state table, analyze and minimize the number of states. 3. Design a clocked synchronous FSM for a sequence detector (e.g., detect 1011). 4. Draw an ASM chart for a traffic light controller. 5. Model a CSSN with specified input-output behavior using Mealy architecture.
CO-2	1. Analyze the flow table of an ASC and identify races. 2. Compare the performance of synchronous vs asynchronous circuits in terms of delay and control. 3. Design an ASC with minimized flow table and safe state assignment. 4. Implement an ALU block using basic logic gates and define its control unit. 5. Design a stable asynchronous system for detecting dual inputs with different delays.
CO-3	1. Identify and classify the types of hazards present in the given logic circuit. 2. Construct a fault table for a given combinational circuit. 3. Use the Boolean difference method to determine test conditions for a stuck-at fault. 4. Apply the path sensitization method to generate a test vector. 5. Detect fault propagation in a logic circuit using the Kohavi algorithm.
CO-4	1. Explain the impact of interconnect parasitics on signal timing. 2. Explain the role of LEF files in physical design. 3. Illustrate the architecture of BIST and its role in self-testing. 4. Differentiate between FEOL and BEOL processes with suitable examples.
Sample assignment questions: 1. Design a simple Arithmetic Logic Unit (ALU) with Flow Table Reduction and Hazard Handling.	

2. Design and analysis of a traffic Light Controller Using Mealy and Moore Machines.
3. Design of a Hazard-Free Circuit for a Critical Application.

Prepared By,
Chinchu Jose
Asst Prof, ECE Dept.

EDUCATION IS DEDICATION

24ECE416	OBJECT ORIENTED PROGRAMMING	L	T	P	R	C	Year of Introduction
		3	1	2	0	5	2025

Preamble:
This elective course aims to provide basics of Object Oriented Programming (OOP) using C++ and Java. Students will learn key OOP concepts like classes, objects, inheritance, and polymorphism, and how they are used to write better programs. The course also includes an introduction to Android app development, where students will learn to build simple mobile applications using basic UI components and data storage.

Prerequisite: Programming in C, Data Structures, Design and Engineering

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

CO 1	Explain the principles and benefits of object-oriented programming**[Understand]**
CO 2	Apply object-oriented features such as classes, objects, inheritance, and polymorphism using C++ and Java [**Apply]**
CO 3	Apply various object-oriented programming concepts and constructs to solve simple real-world problems. **[Apply]**
CO 4	Demonstrate the development of basic Android applications with UI and data storage features. **[Apply]**

CO - PO MAPPING

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	√	√	√	√
Understand	√	√	√	√
Apply	√	√	√	√
Analyze				
Evaluate				
Create				

Mark Distribution of CIA

			Theory [L- T]	**Practical [P]**	

Course Structure [L-T-P-R]	Attendance	Assignment	Test-1	Test-2	Continuous Assessment	Lab Exam	Total Marks
3-1-2-0	5	5	7.5	7.5	15	10	50

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	50	50	2 hours

End Semester Examination [ESE]: Pattern			
PATTERN	**PART A**	**PART B**	**ESE Marks**
PATTERN 1	2 Questions from each module. Total of 8 questions, Answer any 6 questions. Each carrying 3 marks Marks: (3x6 =18 marks)	2 questions will be given from each module, out of which 1 should be answered. Each question can have a maximum of two sub-divisions. Each question carries 8 marks. Marks: (8x4 = 32 marks)	50

SYLLABUS

MODULE I:OOP Fundamentals and C++ Basics (12 hours)

Introduction to OOP concepts - Comparison of procedural vs OOP - Principles of OOP (Encapsulation, Abstraction, Inheritance, Polymorphism) - Benefits and applications of OOP- Structure of C++ program - Classes and objects in C++ - Constructors and destructors

Self- Study: 20 Hrs

1. Explore the role of OOP in simulating real-world entities and processes in applications such as virtual classrooms or smart home automation systems.
2. Implement the concept of virtual base classes in C++ by modeling a real-world scenario, such as a school management system or employee hierarchy
3. Develop a C++ program using constructor overloading to model a real-world object, such as an employee record or product with multiple initialization options.

MODULE II: Advanced C++ Concepts (12 hours)

Operator overloading (unary and binary) - Friend functions and operator overloading -

String manipulation using operators - Inheritance types (single, multiple, multilevel, hierarchical) - Virtual base classes and abstract classes - Constructors in derived classes - Nested classes

Self- Study: 20 Hrs

1. Implement a C++ class for a banking system that uses friend functions and operator overloading to manage balance operations securely and efficiently.
2. Design a C++ program to perform complex number arithmetic using unary and binary operator overloading for real-world engineering computations.
3. Model an employee management system using various types of inheritance (single, multiple, multilevel, hierarchical) to represent roles, departments, and hierarchy.

MODULE III: Java Programming (11 hours)

Overview of Java language - Classes, objects and methods in Java - Method overloading and overriding - Inheritance in Java - Final variables and methods - Interfaces and packages - Exception handling - Multithreaded programming

Self- Study: 21 Hrs

1. Implement a Java program for a billing system that uses final variables for tax rates and final methods to prevent changes in discount calculation logic.
2. Write a Java program that models a real-world system like a library or student record system using appropriate classes, objects, and methods.
3. Develop a Java program to create and run two threads that print numbers from 1 to 10 concurrently.

MODULE IV: Android Development Basics (10 hours)

Android architecture overview - Android application components - Basic UI design and layouts - Intents and intent filters - Content providers and SQLite - Android manifest file, Permissions, SDK- Layouts and Drawable Resources, Styles and Themes - Basic UI and Emulator Setup - SQLite Programming - Case Study: Develop an App to demonstrate database usage

Self- Study: 20 Hrs

1. Develop an Android app such as a contact manager that uses Content Providers and SQLite to store and retrieve data securely..
2. Develop an Android application that allows faculty to manage student attendance by storing and querying records using SQLite.
3. Build a simple Android note app on an emulator that uses text fields for input, buttons for saving, and Recycler View for listing notes.
4. A group assignment on a simple android mobile app (eg: managing students' details and rank calculation of a class)

LESSON PLAN FOR LAB COMPONENT (24 Hrs)

No.	Topic	No. of Hours	Experiment
1.	OOP Fundamentals and C++ Basics	6	1) Create a class in C++ with constructor overloading.
			2) Demonstrate encapsulation and abstraction using classes and objects.
2.	Advanced C++ Concepts	6	1) Write a C++ program demonstrating unary and binary operator overloading.
			2) Implement a program using single and multilevel inheritance.
3.	Java Programming	6	1) Create a Java class demonstrating method overloading and overriding.
			2) Write a Java program to create and run two threads concurrently.
4.	Android Development Basics	6	1) Develop a simple Android app with UI layouts and intent handling.
			2) Create an Android app to store and retrieve data using SQLite.

Textbooks

1. E. Balagurusamy, Object Oriented Programming with C++ and JAVA, 6th ed. New Delhi, India: McGraw-Hill Education, 2015.
2. B. Hardy and B. Phillips, Android Programming: The Big Nerd Ranch Guide, 1st ed. Boston, MA, USA: Addison-Wesley Professional, 2013.
3. Y. P. Kanetkar, Let Us C++, 2nd ed. New Delhi, India: BPB Publications, 2003.

Reference books
1. H. M. Deitel and P. J. Deitel, Java: How to Program, 7th Int. ed., Upper Saddle River, NJ, USA: Pearson Education, 2007, pp. 390–420.
2. G. Booch, R. A. Maksimchuk, M. W. Engel, and B. J. Young, Object-Oriented Analysis and Design with Applications, 3rd ed., Boston, MA, USA: Addison-Wesley, 2007.
3. C. S. Horstmann and G. Cornell, Core Java 2: Volume I, Fundamentals, 5th ed., Delhi, India: Pearson Education, 2002.
4. B. Stroustrup, The C++ Programming Language, 1st ed., Delhi, India: Pearson Education India, 1986.

NPTEL/SWAYAM Courses for reference:
1. NPTEL :: Programming in JAVA - IIT Kharagpur
   https://onlinecourses.nptel.ac.in/noc25_cs110/preview
2. NPTEL :: Programming in modern C++ - IIT Kharagpur
   https://onlinecourses.nptel.ac.in/noc25_cs144/preview

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours [45 hours]
	MODULE 1 [12 hours]	
1.1	Introduction to OOP concepts	1
1.2	Procedural vs. Object-Oriented Programming	2
1.3	Principles of OOP: Encapsulation, Abstraction, Inheritance, Polymorphism	2
1.4	Benefits and Applications of OOP	1
1.5	Overview and Structure of a C++ Program	2
1.6	Classes and Objects	2
1.7	Constructors and Destructors	2
	MODULE II [12 hours]	
2.1	Operator Overloading: Unary and Binary Operators	2
2.2	Operator Overloading using Friend Functions	1
2.3	String Manipulation using Overloaded Operators	2
2.4	Inheritance: Multilevel, Multiple, Hierarchical, Hybrid Inheritance	2
2.5	Virtual Base Classes and Abstract Classes	2
2.6	Constructors in Derived Classes	1
2.7	Nesting of Classes	2
	MODULE III [11 hours]	
3.1	Overview of Java language	1
3.2	Classes, Objects, and Methods in Java	2
3.3	Method Overloading and Inheritance	2
3.4	Overriding Methods, Final Variables, and Methods	2
3.5	Interfaces and Packages	2
3.6	Multithreading and Exception Handling in Java	2

MODULE IV [10 hours]		
4.1	Android architecture overview	1
4.2	Basic Building Blocks: Activities, Services, Broadcast Receivers, Content Providers	1
4.3	UI Components: Views and Notifications	1
4.4	Communication Components: Intents and Intent Filters	1
4.5	App Structure: Manifest File, Permissions, SDK	2
4.6	Layouts and Drawable Resources, Styles and Themes	1
4.7	Creating a Basic UI and Emulator Setup	1
4.8	SQLite Programming with Content Providers	2
4.9	Case Study: Develop an Android App Demonstrating Database Usage	1

CO Assessment Questions	
CO-1	3 Marks 1. Define encapsulation with a C++ example. 2. Differentiate between classes and objects in C++. 3. Compare procedural and object-oriented programming paradigms. 9 Marks 1. Discuss the structure of a C++ program and explain each section. 2. Write a C++ program to implement a class Rectangle with area and perimeter functions using constructors. 3. Explain the key differences between procedural and object-oriented programming paradigms with suitable examples.
CO-2	3 Marks 1. Explain the purpose of friend functions in C++. 2. Distinguish between single and multiple inheritance. 3. Define abstract class and explain its usage in C++. 9 Marks 1. Explain and implement a real-world example using inheritance, like a Vehicle class hierarchy. 2. Write a C++ program to overload the binary '+' operator for a Complex class to add two complex numbers. 3. Differentiate between multiple and multilevel inheritance with the help of diagrams and example code.
CO-3	3 Marks 1. Compare inheritance in Java with C++. 2. Define a thread in Java. How is it created? 3. What are interfaces in Java? How are they different from abstract classes? 9 Marks 1. Develop a multithreaded Java program to print numbers using two threads. 2. Write a Java program to demonstrate method overriding using inheritance.

CO-4	3 Marks 1. What are the core components of an Android application? 2. List different Android layouts and their use cases. 3. What is an intent filter? How does it work? 9 Marks 1. Explain the process of creating and using a custom content provider in Android. When would you prefer using content providers over SQLite? 2. Explain the architecture of an Android application with a diagram. Describe how an app transitions between activities and how intents and permissions play a role in this flow.

Prepared by:
Dr G R Gnana King,
Professor, ECE