SEMESTER 4

APPLIED ELECTRONICS & INSTRUMENTATION

SEMESTER S4

MATHEMATICS FOR ELECTRICAL SCIENCE – 4

(Group B)

Course Code	**GBMAT401**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	Basic calculus	**Course Type**	Theory

Course Objectives:

1. To familiarize students with the foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and science.
2. To expose the students to the basics of random processes essential for their subsequent study of analog and digital communication

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Random variables, Discrete random variables and their probability distributions, Cumulative distribution function, Expectation, Mean and variance, Binomial distribution, Poisson distribution, Poisson distribution as a limit of the binomial distribution, Joint pmf of two discrete random variables, Marginal pmf, Independent random variables, Expected value of a function of two discrete variables. **[Text 1: Relevant topics from sections 3.1 to 3.4, 3.6, 5.1, 5.2]**	**9**
2	Continuous random variables and their probability distributions, Cumulative distribution function, Expectation, Mean and variance, Uniform, Normal and Exponential distributions, Joint pdf of two Continuous random variables, Marginal pdf, Independent random variables, Expectation value of a function of two continuous variables. **[Text 1: Relevant topics from sections 3.1, 4.1, 4.2, 4.3, 4.4, 5.1, 5.2]**	**9**

3	Confidence Intervals, Confidence Level, Confidence Intervals and One-side confidence intervals for a Population Mean for large and small samples (normal distribution and *t*-distribution), Hypotheses and Test Procedures, Type I and Type II error, *z* Tests for Hypotheses about a Population Mean (for large sample), *t* Test for Hypotheses about a Population Mean (for small sample), Tests concerning a population proportion for large and small samples. **[Text 1: Relevant topics from 7.1, 7.2, 7.3, 8.1, 8.2, 8.3, 8.4]**	**9**
4	Random process concept, classification of process, Methods of Description of Random process, Special classes, Average Values of Random Process, Stationarity- SSS, WSS, Autocorrelation functions and its properties, Ergodicity, Mean-Ergodic Process, Mean-Ergodic Theorem, Correlation Ergodic Process, Distribution Ergodic Process. **[Text 2: Relevant topics from Chapter 6]**	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the concept, properties and important models of discrete random variables and to apply in suitable random phenomena.	**K3**
CO2	Understand the concept, properties and important models of continuous random variables and to apply in suitable random phenomena.	**K3**
CO3	Estimate population parameters, assess their certainty with confidence intervals, and test hypotheses about population means and proportions using *z*-tests and the one-sample *t*-test.	**K3**
CO4	Analyze random processes by classifying them, describing their properties, utilizing autocorrelation functions, and understanding their applications in areas like signal processing and communication systems.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Probability and Statistics for Engineering and the Sciences	Devore J. L	Cengage Learning	9th edition, 2016
2	Probability, Statistics and Random Processes	T Veerarajan	The McGraw-Hill	3rd edition, 2008

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Probability, Random Variables and Stochastic Processes,	Papoulis, A. &Pillai, S.U.,	McGraw Hill.	4th edition, 2002
2	Introduction to Probability and Statistics for Engineers and Scientists	Ross, S. M.	Academic Press	6th edition, 2020
3	Probability and Random Processes	Palaniammal, S.	PHI Learning Private Limited	3rd edition, 2015
4	Introduction to Probability	David F. Anderson, Timo, Benedek	Cambridge	1st edition, 2017

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/117/105/117105085/
2	https://archive.nptel.ac.in/courses/117/105/117105085/
3	https://archive.nptel.ac.in/courses/117/105/117105085/
4	https://archive.nptel.ac.in/courses/117/105/117105085/

SEMESTER S4

SIGNALS AND SYSTEMS

Course Code	**PCECT402**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	**ESE Marks**	60
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	Mathematics for Electrical and Physical Sciences (GYMAT101, GYMAT201)	**Course Type**	Theory

Course Objectives:

1. To provide sufficient understanding of different types of signals and systems in time and frequency domain.
2. Analyze LTI systems in time and frequency domain using different transforms.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to signals and systems:** Continuous time and discrete time signals - Elementary signals, Classification of signals, Basic signal operations. Continuous time and discrete time systems – Representation and Classification (memory, causal, stable, linear, time-invariant, invertible) Convolution integral and convolution sum operations. Continuous time and discrete time LTI systems-Stability and causality of LTI systems.	**11**
2	**Frequency domain representation of continuous time signals:** Continuous time Fourier series - Exponential Fourier series representation of periodic signals. Continuous time Fourier transform - Convergence and Gibbs phenomenon, Continuous time Fourier transform of standard signals, Properties of Continuous time Fourier transform, Inverse Transform.	**11**

	Bilateral Laplace Transform, Concept of ROC, Relation of Laplace transform to Fourier Transform.	
3	**Sampling of continuous time signals to discrete signals and frequency domain representation of discrete time signals:** Conversion of continuous time signal to discrete time signal, Sampling theorem for lowpass signals, Nyquist criteria, Aliasing. Discrete time Fourier series for discrete periodic signals. Discrete time Fourier transform (DTFT)-Convergence condition, DTFT of standard signals, Properties of DTFT, Inverse transform. Z transform- ROC, Properties (Proof not needed), Inverse transform, Relation between DTFT and Z-Transform.	**11**
4	**Analysis of LTI systems using Transforms** Concept of transfer function-Frequency response, Magnitude response and phase response. Analysis of Continuous time LTI systems using Laplace and Fourier transforms. Analysis of discrete time LTI systems using DTFT and Z transforms, Stability and causality using Z transform.	**11**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Classify continuous and discrete time signals and systems based on their properties and perform basic operations on signals.	**K2**
CO2	Determine the stability and causality of LTI systems using convolution operations.	**K3**
CO3	Analyze signals in frequency domain using various transforms and examine their properties.	**K3**
CO4	Interpret the use of various transforms to analyze continuous and discrete time LTI systems.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1			2							1
CO2	3	3	2	2	2							2
CO3	3	3	3	2	2							3
CO4	3	3	3	3	2							3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Signals and Systems	Alan V. Oppenheim and Alan Willsky	Pearson	2/e, 2015
2	Signals and Systems	Simon Haykin	John Wiley	2/e, 2021

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Signals and Systems	Anand Kumar	PHI	3/e, 2013
2	Principles of Signal Processing & Linear systems	B P. Lathi	Oxford University Press	2/e, 2009
3	Signals & Systems - Continuous and Discrete	Rodger E. Ziemer	Pearson	4/e, 2013
4	Analog and Digital Signal Processing	Ashok Ambardar	Brooks/Cole Publishing Company	2/e, 2013
5	Signals and systems - Principles and Applications	ShailaDinkarApte	Cambridge University Press	1/e, 2016

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/117101055 https://nptel.ac.in/courses/117104074 https://nptel.ac.in/courses/108104100
2	https://nptel.ac.in/courses/117101055 https://nptel.ac.in/courses/117104074 https://nptel.ac.in/courses/108104100
3	https://nptel.ac.in/courses/117101055 https://nptel.ac.in/courses/117104074 https://nptel.ac.in/courses/108104100
4	https://nptel.ac.in/courses/117101055 https://nptel.ac.in/courses/117104074 https://nptel.ac.in/courses/108104100

SEMESTER S4

LINEAR INTEGRATED CIRCUITS

Course Code	**PCECT403**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	**ESE Marks**	60
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	Analog Circuits (PCECT303)/Electronic Devices and Circuits (PCAET302)	**Course Type**	Theory

Course objective:

1. To develop skills to design and analyze circuits using operational amplifiers for various applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Differential Amplifiers:** Differential amplifier configurations using BJT, DC Analysis - transfer characteristics; AC analysis - 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.	**11**
2	**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, Virtual ground concept. Analysis of inverting and non-inverting amplifier 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	**11**

	converters, Integrator, Differentiator, Precision Rectifiers, Comparators, Schmitt Triggers, Log and Antilog amplifiers.	
3	**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.	**11**
4	**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.	**11**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Summarize the concept of operational amplifiers and differential amplifier configurations	**K2**
CO2	Design operational amplifier circuits for various applications	**K3**
CO3	Choose integrated circuit chips for various linear circuit applications	**K2**
CO4	Implement various applications using specific integrated circuit chips	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										1
CO2	3	2	3	3	2							2
CO3	3				2							2
CO4	3	2	2	2	2							2

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Linear Integrated Circuits	Roy D. C. and S. B. Jain	New Age International	5/e, 2018

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Design with Operational Amplifiers and Analog Integrated Circuits	Sergio Franco	Tata McGraw Hill	3/e, 2017
2	Op-Amps and Linear Integrated Circuits	Gayakwad R. A.	Prentice Hall	4/e, 2015
3	Integrated Circuits	Botkar K. R.	Khanna Publishers	10/e, 2013
4	Operational Amplifiers	C.G. Clayton	Butterworth & Company Publ. Ltd. Elsevier	5/e, 2005
5	Operational Amplifiers & Linear Integrated Circuits	R.F. Coughlin & Fredrick Driscoll	PHI	6/e, 2000
6	Operational Amplifiers & Linear ICs	David A. Bell	Oxford University Press	3/e, 2011
7	Microelectronic Circuits	Sedra A. S. and K. C. Smith	Oxford University Press	6/e, 2013

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/117101106
2	https://nptel.ac.in/courses/117101106
3	https://nptel.ac.in/courses/117101106
4	https://nptel.ac.in/courses/117101106

SEMESTER S4

MICROCONTROLLERS

Course Code	PBECT404	CIE Marks	60
Teaching Hours/Week (L: T:P: R)	3:0:0:1	ESE Marks	40
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PBECT304Logic Circuit Design	Course Type	Theory

Course Objectives:

1. To learn Microcontroller architecture and its programming
2. To learn embedded system design to develop a product.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Microcontroller Architecture – General internal architecture, Address bus, Data bus, control bus. The Microcontroller 8051: Features of 8051 microcontroller, Block diagram 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.	9
2	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.	9
3	Programming 8051 Using Assembly Language: Introduction to 8051 assembly language programming. Data types & directives, Concept of subroutine. Software delay programming. Programming 8051 Using Embedded C Language: Introduction to embedded C – advantages.	9
4	Timer / Counter in 8051: Timer registers - Timer0, Timer1. Configuration of timer registers. Timer mode programming. Counter mode. Serial Communication in 8051: Serial communication – modes and	9

	protocols, RS-232 pin configuration and connection. Serial port programming – transmitting and receiving. Programming the interrupts: Use external, timer and serial port interrupts. Interrupt priority settings.	

Suggestion on Project Topics

Students have to implement a microproject using 8051 microcontroller in hardware. Typical example projects are given below.

1. Interface any known ADC chip to 8051 uC. Read the variation in voltage from a potentiometer and display it on an LCD module.
2. Interface any known DAC chip to 8051 uC. Generate a Sine waveform of 1KHz at any port pin.
3. DC motor interface for speed and direction control.
4. Stepper motor interface - Unit step control, Rotation angle control, Speed control, Direction control
5. Read the Temperature sensor and display it on LCD.

Course Assessment Method
(CIE: 60 marks, ESE: 40 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	Internal Ex-1	Internal Ex-2	Total
5	30	12.5	12.5	60

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 2 marks **(8x2 =16 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 sub divisions. • Each question carries 6 marks. **(4x6 = 24 marks)**	**40**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Outline the architecture of a Microcontroller	**K2**
CO2	Develop Microcontroller programs	**K5**
CO3	Design various interfaces to Microcontroller	**K5**
CO4	Design and implement an Embedded System	**K6**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	The 8051 Microcontroller and Embedded Systems Using Assembly and C	Muhammad Ali Mazidi Janice GillispieMazidi Rolin D. McKinlay	Printice Hall -Inc	Second, 2007
2	The 8051 Microcontroller Architecture, Programming and Applications	Kenneth J Ayala Dhananjay V Gadre	Cengage Learning	2010

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	8051 hardware Description	Datasheet	Intel Corporation	1992
2	Microprocessors and Microcontrollers	Lyla B. Das	Pearson Education	2011

Video Links (NPTEL, SWAYAM…)	
NPTEL course I	Microprocessors and Microcontrollers - https://nptel.ac.in/courses/106108100
NPTEL course II	Microcontrollers and Applications - https://nptel.ac.in/courses/117104072

PBL Course Elements

L: Lecture (3 Hrs.)	R: Project (1 Hr.), 2 Faculty Members		
	Tutorial	**Practical**	**Presentation**
Lecture delivery	Project identification	Simulation/ Laboratory Work/ Workshops	Presentation (Progress and Final Presentations)
Group discussion	Project Analysis	Data Collection	Evaluation
Question answer Sessions/ Brainstorming Sessions	Analytical thinking and self-learning	Testing	Project Milestone Reviews, Feedback, Project reformation (If required)
Guest Speakers (Industry Experts)	Case Study/ Field Survey Report	Prototyping	Poster Presentation/ Video Presentation: Students present their results in a 2 to 5 minutes video

Assessment and Evaluation for Project Activity

Sl. No	Evaluation for	Allotted Marks
1	Project Planning and Proposal	5
2	Contribution in Progress Presentations and Question Answer Sessions	4
3	Involvement in the project work and Team Work	3
4	Execution and Implementation	10
5	Final Presentations	5
6	Project Quality, Innovation and Creativity	3
Total		**30**

1. **Project Planning and Proposal (5 Marks)**

   - Clarity and feasibility of the project plan
   - Research and background understanding
   - Defined objectives and methodology

2. **Contribution in Progress Presentation and Question Answer Sessions (4 Marks)**
    - Individual contribution to the presentation
    - Effectiveness in answering questions and handling feedback

3. **Involvement in the Project Work and Team Work (3 Marks)**
    - Active participation and individual contribution
    - Teamwork and collaboration

4. **Execution and Implementation (10 Marks)**
    - Adherence to the project timeline and milestones
    - Application of theoretical knowledge and problem-solving
    - Final Result

5. **Final Presentation (5 Marks)**
    - Quality and clarity of the overall presentation
    - Individual contribution to the presentation
    - Effectiveness in answering questions

6. **Project Quality, Innovation, and Creativity (3 Marks)**
    - Overall quality and technical excellence of the project
    - Innovation and originality in the project
    - Creativity in solutions and approaches

SEMESTER S4

COMMUNICATION ENGINEERING

Course Code	**PEAET411**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	GXEST104: Introduction to Electrical and Electronics Engineering/ PCAET302: Electronic Devices and Circuits	**Course Type**	Theory

Course Objective:

1. To acquire knowledge about analog and digital communication systems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Analog Communication** Introduction to communication systems, Classification of channels, Need for modulation. Amplitude modulation: Equation and frequency spectrum of AM signal, Double-side band suppressed carrier (DSB-SC) modulation, Single sideband modulation (SSB), comparison of spectrum, power and efficiency of all the three variants, Amplitude modulator circuits -balanced modulator, AM demodulators – Envelope detector.	9
2	**Angle Modulation** Frequency and phase modulation, Narrow and wide band FM and their spectra, Modulation and demodulation techniques for FM, pre-emphasis and de-emphasis, FM transmitter and receiver, Noise in receivers, Noise figures, Performance of analog modulation schemes in AWGN: SNR and figure of merit for different schemes.	9
3	**Digital baseband communication** Elements of digital communication system. Sources, channels and receivers, Sampling and Reconstruction of Analog Signals: Nyquist Sampling Theorem, Ideal Reconstruction Filter, Pulse Amplitude Modulation (PAM), Time division multiplexing with PAM, Pulse Code Modulation (PCM), A-law and mu-law quantization.	9

4	**Digital bandpass communication** Digital bandpass communication system, Bandpass modulation techniques: Amplitude shift keying, Phase shift keying, Frequency shift keying, Methods of generation and detection, Signal constellations, M-ary digital modulation schemes, Quadrature phase shift keying, Minimum shift keying, Quadrature amplitude modulation.	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the working of Amplitude modulator and demodulator circuits using mathematical relations.	**K2**
CO2	Explain the characteristics of various analog modulation schemes in terms of spectra, power and efficiency.	**K3**
CO3	Understand the various processing blocks of a digital communication system.	**K2**
CO4	Apply the knowledge of digital modulation in digital transmission.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Kennedy's Electronic Communication Systems	Kennedy, Davis and Prasanna	Tata McGraw Hill	6th Edition, 2018
2	Electronic Communication Systems – Fundamentals through Advanced	Wayne Tomasi	Pearson	5th Edition, 2008
3	Communication Systems	Simon Haykin and Michael Mohre	Wiley	5th Edition,2021
4	Principles of Communication Systems	Taub& Schilling	McGraw-Hill	4th edition, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Principles of Communications	Rodger E. Ziemer& William H. Tranter	Wiley	7the edition, 2014
2	Communication System Engineering	J. G. Proakis and M. Salehi	Pearson Education	2nd Edition, 2018
3	Digital and Analog Communication Systems	Leon W. Couch	Prentice Hall	8th edition, 2012
4	Modern Digital and Analog Communication Systems	B. P. Lathi, Zhi Ding	Oxford University Press	4th edition, 2011

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/117102059 https://archive.nptel.ac.in/courses/108/104/108104091/
2	https://nptel.ac.in/courses/117102059 https://archive.nptel.ac.in/courses/108/104/108104091/
3	https://nptel.ac.in/courses/117102059 https://archive.nptel.ac.in/courses/108/104/108104091/
4	https://nptel.ac.in/courses/117102059 https://archive.nptel.ac.in/courses/108/104/108104091/

SEMESTER S4

SOLID STATE DEVICES

Course Code	**PEAET412**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	GBPHT121: Physics for Electrical Science	**Course Type**	Theory

Course Objective:

1. To understand the physical processes and working principles of semiconductor devices, while relating the device performance to material parameters and design criteria.

SYLLABUS

Module No.	Syllabus Description	Contact Hors
1	**Review of Semiconductor physics -** Equilibrium and steady state conditions, Concept of effective mass and Fermi level, Density of states & Effective density of states, Equilibrium concentration of electrons and holes. **Excess carriers in semiconductors -** Generation and recombination mechanisms of excess carriers, quasi-Fermi levels. **Carrier transport in semiconductors** - Drift, conductivity and mobility, variation of mobility with temperature and doping, Hall Effect.	**11**
2	Diffusion, Einstein relations, Poisson equations, Continuity equations, Current flow equations, Diffusion length, Gradient of quasi-Fermi level. **PN junctions**: Contact potential, Electrical Field, Potential and Charge distribution at the junction, Biasing and Energy band diagrams, Ideal diode equation. **Bipolar junction transistor** - Working, Transistor action, Base width modulation, Current components in a BJT,	**10**
3	**Ideal MOS capacitor** - Band diagrams at equilibrium, accumulation, depletion and inversion, surface potential, CV characteristics, effects of real surfaces, threshold voltage, body effect. **MOSFET**- Structure, working, types, Drain current equation of enhancement type MOSFET (derivation)- linear and saturation region, Drain characteristics, transfer characteristics.	**8**

4	**MOSFET scaling** - Need for scaling, constant voltage scaling and constant field scaling. Sub-threshold conduction in MOS. **Short channel effects in MOSFETs** - Channel length modulation, Drain Induced Barrier Lowering, Velocity Saturation, Threshold Voltage Variations and Hot Carrier Effects. **FinFET** - Structure, operation and advantages.	**7**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply Fermi-Dirac statistics to compute equilibrium carrier concentration.	**K3**
CO2	Explain different carrier transport mechanisms in extrinsic semiconductors and obtain the currents densities due to this transport.	**K2**
CO3	Apply the theories to solve for the current components of semiconductor devices.	**K3**
CO4	Analyze the response of semiconductor devices for different biasing conditions.	**K3**
CO5	Outline the effects of scaling in semiconductor devices.	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											3
CO2	3	2			2							3
CO3	3	2			2							3
CO4	3	2			3							3
CO5	3	2			3							3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Solid State Electronic Devices.	Ben G. Streetman, Sanjay Kumar Banerjee	Pearson.	7/e, 2023
2	Semiconductor Devices Fundamentals.	Pierret	Pearson	2023
3	CMOS Digital Integrated Circuits: Analysis and Design.	Sung Mo Kang	McGraw-Hill	3/e, 2002

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Semiconductor Physics and Devices	Neamen	McGraw Hill	4/e, 2017
2	Physics of Semiconductor Devices	Sze S.M	John Wiley	3/e, 2015
3	Semiconductor Devices: Physics and Technology	Sze S.M	John Wiley	3/e, 2016
4	Operation and Modelling of the MOS Transistor	YannisTsividis	Oxford University Press	3/e,2010

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/117106091
2	https://nptel.ac.in/courses/117106091
3	https://nptel.ac.in/courses/117106091
4	https://nptel.ac.in/courses/117106091

SEMESTER S4

OPTICAL INSTRUMENTATION

Course Code	**PEAET413**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	PCAET303 Transducers and Measurements	**Course Type**	Theory

Course Objectives:

1. To impart knowledge about the basic concepts of optical fiber, optical sources and optical detectors
2. To introduce the working principle of optical instruments
3. To provide an exposure to the industrial application of fiber optic sensors and lasers.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Optical fiber concepts -** Principle of light propagation through optical fiber – Acceptance angle and acceptance cone – Numerical aperture- V-number – Types of optical fibers (Material, refractive index and modes) and their properties. **Distortions in optical fibers -** Attenuation, material absorption losses, scattering losses, fiber bend loss, dispersions – intermodal and intramodal dispersions. **Optical Fiber fabrication** - Melting method, Vapor phase deposition method. **Optical source -**LED – Edge Emitting LED, Surface Emitting LED **Optical detectors -**Photodiodes, Photo transistors, PIN diodes, Avalanche photodiodes.	**9**
2	**Fiber connections -**Fiber optic connectors, Splicers- splicing issues and splicing techniques, Optical couplers, isolators and circulators.	**9**

	Fiber optic sensors-Fiber optic instrumentation system for measurement of fiber characteristics – attenuation measurement (cut back method), dispersion measurement (Time domain and frequency domain method), Refractive index profile measurements, Optical time domain reflectometers. Fiber numerical aperture measurement. Measurement of pressure, temperature, current, voltage, liquid level and strain. **Optical Modulators -** Different types of modulators – Electro-optic modulators, Magento-optic modulators and Acousto-optic modulators.	
3	**Interferometers -** Types – Fabry-Perot interferometer, Michelson Interferometer and Mach-Zehnder interferometer, Interference filters, Interferometric method for measurement of length – fiber optic gyroscope, Optical spectrum analyzers. **Lasers** - Principles of operation, Einstein relations, Population inversion, Optical feedback, laser modes, Types of lasers – Solid state laser (Ruby laser), gas lasers (He-Ne laser), liquid dye lasers– Semiconductor lasers – Q-switching and mode locking – Properties of laser light.	**9**
4	**Applications of lasers -**Laser for measurement of distance, length, atmospheric effect and pollutants-Laser Doppler Anemometry (LDA) - Material processing: Laser heating, Melting, Scribing, Trimming, Welding. **Medical application of lasers -**Laser and Tissue interaction-Laser diagnosis-Laser instruments for microsurgery, Removal of tumors of vocal chords, Brain surgery, dermatology, Oncology and Ophthalmology.	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To explain the basic concepts and working of optical fibers, optical sources and optical detectors	**K2**
CO2	To acquire knowledge about the fabrication of optical fibers and the distortions that can occur	**K2**
CO3	To recognize the fiber connections and optical modulators	**K2**
CO4	To explain the working operations of interferometers and laser diodes	**K2**
CO5	To identify various real world applications of fiber optic sensors and lasers.	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											3
CO2	3											3
CO3	3											3
CO4	3		3			2						3
CO5	3		3			2						3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fiber-Optic Communications Technology	Djafar.K. Mynbaev, Lowell. Scheiner	Pearson Education	1/e, 2000
2	Optical Fiber Communication	G. Keiser	McGraw Hill	5/e, 2017
3	Fiber optics & Optoelectronics	R.P. Khare	Oxford University Press	2004
4	Optoelectronics	John Wilson and John Hawkes	Pearson Education	3/e, 2018
5	Lasers: Fundamentals and Applications	AjoyGhatakK.Thyagarajan	Laxmi Publications	2/e,2019

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fiber-Optic Communications Technology	D.K. Mynbaev, L. Scheiner	Pearson Education	1/e, 2008
2	Industrial Applications of Lasers	John F. Ready	Academic Press	2/e, 1997
3	Optoelectronics & Photonics: Principles & Practices: International Edition	SafaKasap	Pearson Education	2/e, 2013
4	Semiconductor Optoelectronic Devices	Bhattacharya Pallab	Pearson Education	2/e, 2017
5	Fiber Optic Sensors: An Introduction for Engineers and Scientists	Eric Udd, William B., and Spillman, Jr.	John Wiley & Sons	2/e, 2011

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/102/108/102108082/
2	https://archive.nptel.ac.in/courses/102/108/102108082/
3	https://archive.nptel.ac.in/courses/102/108/102108082/
4	https://archive.nptel.ac.in/courses/102/108/102108082/

SEMESTER S4

DATA STRUCTURES AND ALGORITHMS

Course Code	**PEAET414**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	GXEST204 Programming in C	**Course Type**	Theory

Course objectives:

1. To acquire knowledge about algorithms and their complexities
2. To develop algorithms for sorting, linked list, trees and graphs

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Data Structures** System Life Cycle, Algorithms, Performance Analysis, Space Complexity, Time Complexity, Asymptotic Notation (Big O Notation), Complexity Calculation of Simple Algorithms. Primitive and Non-primitive data structures, Abstract data types, Array as ADT, Operations on ADT (insert, delete, search, sort), Queue as ADT, Circular queue, Priority queue, Stack as ADT.	**9**
2	**Sorting and Searching Algorithms** Sorting algorithms - Selection sort, insertion sort, merge sort, quick sort. Searching algorithms - Linear search and Binary search algorithms. Hashing - Basic concepts of Hashing and hash functions.	**9**
3	**Linked List** Self-Referential Structures, Dynamic Memory Allocation, Singly Linked List - Operations on Linked List, Doubly Linked List, Circular Linked List, Stacks and Queues using Linked List.	**9**
4	**Trees and Graphs** Trees, Binary Trees-Tree Operations, Binary Tree Representation, Tree Traversals, Binary Search Trees- Binary Search Tree Operations. Graphs - Representation of Graphs, Depth First Search and Breadth First Search on Graphs, Applications of Graphs.	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Design an algorithm to do a particular task and calculate its time/space complexities	**K3**
CO2	To familiarize data structures like arrays/linked list and their related operations	**K2**
CO3	Design algorithms for sorting and searching problems	**K4**
CO4	Design data structures for solving real world problems using trees and graphs	**K5**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Algorithms	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein	MIT Press	4th Edition, 2022
2	Data Structures: A Pseudocode Approach with C	Richard F. Gilberg	Cengage India Private Limited	2nd Edition , 2007

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Data structures and algorithm analysis in C	Mark Allen Weiss	Pearson Education	2nd Edition, 2002
2	An Introduction to Data Structures with Application	J P Trembley and P Sorenson	McGraw Hill	2nd Edition, 2017
3	Data Structures and Algorithms	Aho A. V., J. E. Hopcroft and J. D. Ullman	Pearson Education	1st Edition, 2002
4	Data structures using C	Aaron M. Tenanbaum, Y. Langsam and M J Augenstein	PHI	2017
5	Fundamental of Data structure in C	E. Horowitz, S Sahni and S Anderson-Freed	W H Freeman and Co.	1992

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106102064
2	https://nptel.ac.in/courses/106102064
3	https://nptel.ac.in/courses/106102064
4	https://nptel.ac.in/courses/106102064

SEMESTER S4

DIGITAL SYSTEMS AND VLSI DESIGN

Course Code	**PEECT415**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	5/3	**Exam Hours**	2Hr 30 Min
Prerequisites (if any)	PBECT304 Logic Circuit Design	**Course Type**	Theory

Course Objectives:

1. To equip students with comprehensive knowledge and skills in designing, analysing, modelling, and optimizing clocked synchronous sequential networks (CSSNs).
2. To provide a thorough understanding of the designing, analyzing, and optimizing techniques of asynchronous sequential circuits (ASCs).
3. To equip students with the knowledge and skills to identify and mitigate static and dynamic hazards and to understand fault detection and testing methods.
4. To provide students with a comprehensive understanding of the VLSI design flow and the application of VHDL constructs and coding for combinational and sequential circuits**.**

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	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.	**9**
2	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.	**9**

3	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, Automatic test pattern generation – Built in Self-Test (BIST)	**9**
4	VLSI Design flow: Design entry - Schematic, FSM & HDL, VHDL Hardware Description Language, VHDL Modules, VHDL Processes, Different modeling styles in VHDL, Data types and operators, Objects, Dataflow, Behavioral and Structural Modeling, Synthesis, Simulation. VHDL constructs and codes for combinational and sequential circuits.	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	*Internal Ex*	*Evaluate*	*Analyse*	*Total*
5	**15**	**10**	**10**	**40**

Criteria for Evaluation (Evaluate and Analyse): 20 marks

Evaluation Methods:

1. Experiments Using Design and Analysis Tools: (10 marks)

- Students can perform specific experiments using tools like GHDL, iVerilog, ModelSim, Xilinx ISE, Vivado etc.
- Each experiment can focus on designing and simulating different types of circuits (synchronous, asynchronous, combinational, sequential).

2. Course Project:

Comprehensive project involving design, modeling, and analysis of a digital system. (10 marks)

Project phases: Proposal, Design, Implementation, Testing, Final Report.

Presentations and Viva Voce:

- Students present their projects and experiments, explaining design choices, methodologies,

and results.

- Viva voce to assess understanding and ability to answer related questions.

Sample Experiments:

Experiment 1: Basic Mealy/Moore Machine Design

- **Objective:** Design a simple Mealy/Moore machine to detect a specific sequence of bits (e.g., "101").
- **Tools:** VHDL/Verilog, GHDL, iVerilog, ModelSim/Xilinx ISE, Vivado.
- **Steps:**
  1. Draw the state diagram for the sequence detector.
  2. Write the VHDL or Verilog code for the Mealy machine.
  3. Simulate the design to verify its functionality.

Experiment 2: Basic Flow Table Reduction

- **Objective:** Reduce the flow table for a simple asynchronous sequential circuit.
- **Tools:** Manual calculation, VHDL/Verilog for verification.
- **Steps:**
  1. Given a flow table, perform flow table reduction.
  2. Assign binary codes to the reduced states.
  3. Implement the reduced state machine in VHDL or Verilog and simulate it.

Experiment 3: Identifying and Eliminating Static Hazards

- **Objective:** Identify and eliminate static hazards in a simple combinational circuit.
- **Tools:** VHDL/Verilog, GHDL, iVerilog, ModelSim/Xilinx ISE, Vivado.
- **Steps:**
  1. Design a combinational circuit with a known static hazard.
  2. Identify the static hazard in the circuit.
  3. Modify the design to eliminate the static hazard and simulate it.

Experiment 4: Fault Detection Using Path Sensitization

- **Objective:** Use the path sensitization method to detect faults in a simple digital circuit.
- **Tools:** VHDL/Verilog, GHDL, iVerilog, ModelSim/Xilinx ISE, Vivado.
- **Steps:**
  1. Design a simple digital circuit.

2. Apply the path sensitization method to detect faults.
3. Implement and simulate the circuit in VHDL or Verilog to verify fault detection.

Sample Project Topics:

1. Design and Analysis of a Traffic Light Controller Using Mealy and Moore Machines
2. State Reduction and Assignment for a Sequence Detector
3. Design and Analysis of an Asynchronous Sequence Detector
4. Designing a Simple Arithmetic Logic Unit (ALU) with Flow Table Reduction and Hazard Handling
5. Design of a Hazard-Free Circuit for a Critical Application
6. Implementing Data Synchronizers for Mixed Operating Mode Asynchronous Circuits
7. Comprehensive VLSI Design Project Using VHDL (e.g., Digital Clock, ALU, Traffic Light Controller)
8. Synthesis and Simulation of Complex Sequential Circuits Using Different VHDL Modeling Styles

Criteria for Evaluation: Lab Experiments (10 marks)

1. **Understanding of Concepts (3 marks)**
    - Demonstrates a clear understanding of the theoretical concepts related to the experiment.
    - Correctly explains the purpose and expected outcomes of the experiment.
2. **Implementation and Accuracy (3 marks)**
    - Correctly implements the design using appropriate tools.
    - The design functions as expected without errors.
3. **Analysis and Problem-Solving (2 marks)**
    - Effectively analyse the design to identify and resolve issues.
    - Demonstrates problem-solving skills in addressing any encountered challenges.
4. **Documentation and Reporting (1 mark)**
    - Provides clear and concise documentation of the steps and processes followed.
    - The report includes diagrams, code snippets, and simulation results.
5. **Presentation and Communication (1 mark)**
    - Clearly presents the experiment and its results.

- Able to answer questions and explain the design choices.

Criteria for Evaluation: Course Project (10 marks)

1. **Project Proposal and Planning (2 marks)**
    - Submits a well-defined project proposal outlining objectives, methodology, and expected outcomes.
    - Demonstrates thorough planning and a clear timeline for the project.
2. **Design and Implementation (3 marks)**
    - Implements the project design accurately using appropriate tools and techniques.
    - The design is functional and meets the project objectives.
3. **Innovation and Creativity (2 marks)**
    - Introduces innovative ideas or unique approaches in the design and implementation.
    - Demonstrates creativity in solving problems or optimizing designs.
4. **Analysis and Testing (2 marks)**
    - Effectively analyzes the project design to identify and address any issues.
    - Conducts thorough testing to verify the functionality and performance of the design.
5. **Final Report and Presentation (1 mark)**
    - Submits a comprehensive final report detailing the project, including objectives, design, methodology, analysis, and results.
    - Clearly presents the project and its outcomes, and effectively communicates the key points.

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =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 3 sub divisions. Each question carries 9 marks. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Design, analyze, and model clocked synchronous sequential networks (CSSNs), optimize state assignment and reduction, and effectively utilize ASM charts for the realization of complex digital systems.	**K3**
CO2	Design and analyze asynchronous sequential circuits (ASCs), perform flow table reduction, address race conditions and state assignment problems, and design both ASCs and Arithmetic Logic Units (ALUs).	**K3**
CO3	Identify and mitigate static and dynamic hazards in combinational networks, design hazard-free circuits, address practical issues in digital systems and apply fault detection and testing methods.	**K2**
CO4	Understand the VLSI design flow, utilize various design entry methods, apply different VHDL modeling styles, and develop and simulate VHDL constructs for combinational and sequential circuits.	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2									
CO2	3	2	2									
CO3	3	1	2									
CO4	1	1	2	1	2							

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Principles & Design	Donald G Givone	McGraw Hill Education	2017
2	Digital Design: Principles and Practices	John F Wakerly	Pearson India	4th, 2008
3	Digital Logic Applications and Design	John M Yarbrough	Cengage Learning India	1st, 2006
4	Digital Design: With an Introduction to the Verilog HDL, VHDL, and SystemVerilog	M.Morris Mano and Michel.D.Ciletti,	Pearson	6th, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Systems Testing and Testable Design	Melvin A. Breuer, Miron Abramovici, Arthur D. Friedman	Wiley-IEEE Press	1st, 1994
2	Logic Design Theory	Nripendra N. Biswas	Prentice Hall	1993
3	Introduction to Digital Design Using Digilent FPGA Boards: Block Diagram / VHDL Examples	Richard E. Haskell Darrin M. Hanna	LBE Books- LLC	2019
4	Digital Circuits and Logic Design	Samuel C. Lee	Prentice Hall India Learning Private Limited	1980
5	Switching and Finite Automata Theory	Zvi Kohavi, Niraj K. Jha	CAMBRIDGE UNIVERSITY PRESS	3rd 2009
6	Digital System Design Using VHDL	Rishabh Anand	Khanna Publishing	1st, 2013
7	Digital System Design Using VHDL	Lizy Kurian John, Charles H. Roth	Cengage	1st, 2012

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/117/106/117106086/
2	https://archive.nptel.ac.in/courses/117/106/117106086/
3	https://archive.nptel.ac.in/courses/108/105/108105132/ Lecture 15
4	https://nptel.ac.in/courses/108106177

SEMESTER S4

MACHINE LEARNING

Course Code	**PEAET495**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	**3:0:0:0**	**ESE Marks**	60
Credits	**5/3**	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	GNEST305: Introduction to Artificial Intelligence and Data Science	**Course Type**	Theory

Course Objectives

1. To introduce the prominent methods for machine learning
2. To study the basics of supervised and unsupervised learning

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Overview of machine learning** Introduction to Machine Learning, Examples of machine learning applications. Machine learning paradigms - supervised, semi-supervised, unsupervised, reinforcement learning. Types of supervised learning - Classification, Regression. Bayes' theorem. Classification - Bayes' decision theory, discriminant functions and decision surfaces, Bayesian classification for normal distributions, Naive Bayes Classifiers, Logistic regression.	9
2	**Supervised Learning** Regression - Error functions in regression, Linear regression with one variable, Linear regression with multiple variables, Over-fitting and underfitting. Bias-variance trade-off. Basics of decision trees, random forest. SVM - Maximum Margin Classification, Separable and non-separable classes: Formulation of the Optimization problem and solutions, Multiclass case.	9

3	**Neural Networks (NN)** Perceptron, Neural Network - Multilayer feed forward network, Activation functions (Sigmoid, ReLU, Tanh), Backpropagation algorithm. **Unsupervised Learning** Clustering -Distance measures, K-means clustering, Hierarchical Clustering	**9**
4	**Dimensionality reduction** - principal component analysis, Fischer's discriminant analysis. **Model selection -** Cross validation – K-fold, Leave One Out, Bootstrapping. **Model Evaluation -**Classification- Confusion matrix,Precision, Recall, Accuracy, F-Measure, ReceiverOperating Characteristic Curve (ROC), Area Under Curve (AUC).	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	*Internal Ex*	*Evaluate*	*Analyse*	*Total*
5	**15**	**10**	**10**	**40**

Criteria for Evaluation (Evaluate and Analyze): 20 marks

- Each student should design, implement, and analyze machine learning algorithms for various applications.
- **Each student should implement minimum two algorithms learnt during the course and compare their performance using the evaluation metrics.**
- **Students must also take up a course project on supervised learning, unsupervised learning or Dimensionality reduction application of machine learning.**
- Students may use any of the readily available open-source datasets online or collect the data themselves (and label it if necessary).
- Students can use Python or MATLAB for implementation.
- Each student must prepare a 5–10 page report with the details broadly outlined (but not limited to) as follows:
    - Introduction
        - What is the problem?
        - Why is it important?
        - What is your basic approach?
        - A basic summary of your results and conclusions
    - Problem Definition and Algorithm

- Task Definition – Elaborate on your problem, Specify inputs and outputs
- Algorithm Definition –
  - How the algorithm solves the problem?
  - Pseudo-code

- Experimental Evaluation
  - Methodology – Model evaluation strategy
  - Results
- Conclusion
- Bibliography

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain machine learning concepts like supervised, and unsupervised and reinforcement learning	**K2**
CO2	Apply multiple concepts in supervised and unsupervised learning to create applications	**K5**
CO3	Illustrate the concepts of Multilayer neural network and Support Vector Machine	**K2**
CO4	Apply classifier performance measures for evaluating different classifiers.	**K5**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Machine Learning	EthemAlpaydin	MIT Press	2nd Edition, 2010
2	Data Mining and Analysis: Fundamental Concepts and Algorithms	Mohammed J. Zaki and Wagner MeiraJr	Cambridge University Press	1st Edition, 2014
3	Python Data Science Handbook	Jake VanderPlas	O'Reilly Media	2nd Edition, 2016

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Neural Networks for Pattern Recognition	Christopher Bishop	**Clarendon Press**	1995
2	Machine Learning: A Probabilistic Perspective	Kevin P. Murphy	MIT Press	2012
3	Elements of Machine Learning	P. Langley	Morgan Kaufmann	1995
4	The Elements Of Statistical Learning	Trevor Hastie, Robert Tibshirani, Jerome Friedman	Springer	2nd edition, 2007

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106106139 https://www.youtube.com/watch?v=T3PsRW6wZSY
2	https://nptel.ac.in/courses/106106139 https://www.youtube.com/watch?v=5WCkrDI7VCs https://www.youtube.com/watch?v=FuJVLsZYkuE
3	https://nptel.ac.in/courses/106106139 https://www.youtube.com/watch?v=gidJbK1gXmA https://www.youtube.com/watch?v=T6WLIbOnkvQ
4	https://nptel.ac.in/courses/106106139 https://www.youtube.com/watch?v=CwjLMV52tzI

SEMESTER S3/S4

ECONOMICS FOR ENGINEERS

(Common to All Branches)

Course Code	**UCHUT346**	**CIE Marks**	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. Understanding of finance and costing for engineering operation, budgetary planning and control
2. Provide fundamental concept of micro and macroeconomics related to engineering industry
3. Deliver the basic concepts of Value Engineering.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic Economics Concepts - Basic economic problems – Production Possibility Curve – Utility – Law of diminishing marginal utility – Law of Demand - Law of supply – Elasticity - measurement of elasticity and its applications – Equilibrium- Changes in demand and supply and its effects Production function - Law of variable proportion – Economies of Scale – Internal and External Economies – Cobb-Douglas Production Function	**6**
2	Cost concepts – Social cost, private cost – Explicit and implicit cost – Sunk cost - Opportunity cost - short run cost curves - Revenue concepts Firms and their objectives – Types of firms – Markets - Perfect Competition – Monopoly - Monopolistic Competition - Oligopoly (features and equilibrium of a firm)	**6**
3	Monetary System – Money – Functions - Central Banking –Inflation - Causes and Effects – Measures to Control Inflation - Monetary and Fiscal policies – Deflation	**6**

	Taxation – Direct and Indirect taxes (merits and demerits) - GST National income – Concepts - Circular Flow – Methods of Estimation and Difficulties - Stock Market – Functions- Problems faced by the Indian stock market-Demat Account and Trading Account – Stock market Indicators-SENSEX and NIFTY	
4	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 - Cost-Benefit Analysis - Capital Budgeting - Process planning	**6**

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Case study/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
10	**15**	**12.5**	**12.5**	**50**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• Minimum 1 and Maximum 2 Questions from each module. • Total of 6 Questions, each carrying 3 marks **(6x3 =18marks)**	• 2 questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 2 sub divisions. • Each question carries 8 marks. **(4x8 = 32 marks)**	**50**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamentals of various economic issues using laws and learn the concepts of demand, supply, elasticity and production function.	**K2**
CO2	Develop decision making capability by applying concepts relating to costs and revenue, and acquire knowledge regarding the functioning of firms in different market situations.	**K3**
CO3	Outline the macroeconomic principles of monetary and fiscal systems, national income and stock market.	**K2**
CO4	Make use of the possibilities of value analysis and engineering, and solve simple business problems using break even analysis, cost benefit analysis and capital budgeting techniques.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	1	-	-	-	-	1	-
CO2	-	-	-	-	-	1	1	-	-	-	1	-
CO3	-	-	-	-	1	-	-	-	-	-	2	-
CO4	-	-	-	-	1	1	-	-	-	-	2	-

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Managerial Economics	Geetika, PiyaliGhosh and Chodhury	Tata McGraw Hill,	2015
2	Engineering Economy	H. G. Thuesen, W. J. Fabrycky	PHI	1966
3	Engineering Economics	R. Paneerselvam	PHI	2012

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Engineering Economy	Leland Blank P.E, Anthony Tarquin P. E.	McGraw Hill	7^{TH} Edition
2	Indian Financial System	Khan M. Y.	Tata McGraw Hill	2011
3	Engineering Economics and analysis	Donald G. Newman, Jerome P. Lavelle	Engg. Press, Texas	2002
4	Contemporary Engineering Economics	Chan S. Park	Prentice Hall of India Ltd	2001

SEMESTER S3/S4

ENGINEERING ETHICS AND SUSTAINABLE DEVELOPMENT

Course Code	**UCHUT347**	**CIE Marks**	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. Equip with the knowledge and skills to make ethical decisions and implement gender-sensitive practices in their professional lives.
2. Develop a holistic and comprehensive interdisciplinary approach to understanding engineering ethics principles from a perspective of environment protection and sustainable development.
3. Develop the ability to find strategies for implementing sustainable engineering solutions.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Fundamentals of ethics** - Personal vs. professional ethics, Civic Virtue, Respect for others, **Profession and Professionalism,** Ingenuity, diligence and responsibility, Integrity in design, development, and research domains, Plagiarism, a balanced outlook on law - challenges - case studies, **Technology and digital revolution**-Data, information, and knowledge, Cybertrust and cybersecurity, Data collection & management, **High technologies: connecting people and places**-accessibility and social impacts, **Managing conflict**, Collective bargaining, **Confidentiality**, Role of confidentiality in moral integrity, **Codes of Ethics**. **Basic concepts in Gender Studies** - sex, gender, sexuality, gender spectrum: beyond the binary, gender identity, gender expression, gender stereotypes, **Gender disparity and discrimination in education**,	6

	employment and everyday life, History of women in Science & Technology, Gendered technologies & innovations**, Ethical values and practices in connection with gender** - equity, diversity & gender justice, **Gender policy and women/transgender empowerment initiatives.**	
2	**Introduction to Environmental Ethics:** Definition, importance and historical development of environmental ethics, key philosophical theories (anthropocentrism, biocentrism, ecocentrism). **Sustainable Engineering Principles:** Definition and scope, triple bottom line (economic, social and environmental sustainability), life cycle analysis and sustainability metrics. **Ecosystems and Biodiversity:** Basics of ecosystems and their functions, Importance of biodiversity and its conservation, Human impact on ecosystems and biodiversity loss, An overview of various ecosystems in Kerala/India, and its significance. **Landscape and Urban Ecology:** Principles of landscape ecology, Urbanization and its environmental impact, Sustainable urban planning and green infrastructure.	**6**
3	**Hydrology and Water Management:** Basics of hydrology and water cycle, Water scarcity and pollution issues, Sustainable water management practices, Environmental flow, disruptions and disasters. **Zero Waste Concepts and Practices:** Definition of zero waste and its principles, Strategies for waste reduction, reuse, reduce and recycling, Case studies of successful zero waste initiatives. **Circular Economy and Degrowth:** Introduction to the circular economy model, Differences between linear and circular economies, degrowth principles, Strategies for implementing circular economy practices and degrowth principles in engineering. **Mobility and Sustainable Transportation:** Impacts of transportation on the environment and climate, Basic tenets of a Sustainable Transportation design, Sustainable urban mobility solutions, Integrated mobility systems, E-Mobility, Existing and upcoming models of sustainable mobility solutions.	**6**
4	**Renewable Energy and Sustainable Technologies:** Overview of renewable energy sources (solar, wind, hydro, biomass), Sustainable technologies in energy production and consumption, Challenges and opportunities in renewable energy adoption. **Climate Change and Engineering Solutions:** Basics of climate change science, Impact of climate change on natural and human systems, Kerala/India and the Climate crisis, Engineering solutions to mitigate, adapt and build resilience to climate change. **Environmental**	**6**

	Policies and Regulations: Overview of key environmental policies and regulations (national and international), Role of engineers in policy implementation and compliance, Ethical considerations in environmental policy-making. **Case Studies and Future Directions:** Analysis of real-world case studies, Emerging trends and future directions in environmental ethics and sustainability, Discussion on the role of engineers in promoting a sustainable future.	

Course Assessment Method
(CIE: 50 marks , ESE: 50)

Continuous Internal Evaluation Marks (CIE):

Continuous internal evaluation will be based on individual and group activities undertaken throughout the course and the portfolio created documenting their work and learning. The portfolio will include reflections, project reports, case studies, and all other relevant materials.

- The students should be grouped into groups of size 4 to 6 at the beginning of the semester. These groups can be the same ones they have formed in the previous semester.
- Activities are to be distributed between 2 class hours and 3 Self-study hours.
- The portfolio and reflective journal should be carried forward and displayed during the 7th Semester Seminar course as a part of the experience sharing regarding the skills developed through various courses.

Sl. No.	Item	Particulars	Group/Individual (G/I)	Marks
1	Reflective Journal	Weekly entries reflecting on what was learned, personal insights, and how it can be applied to local contexts.	I	5
2	Micro project (Detailed documentation of the project, including methodologies, findings, and reflections)	1 a) Perform an Engineering Ethics Case Study analysis and prepare a report 1 b) Conduct a literature survey on 'Code of Ethics for Engineers' and prepare a sample code of ethics	G	8
		2. Listen to a TED talk on a Gender-related topic, do a literature survey on that topic and make a report citing the relevant papers with a specific analysis of the Kerala context	G	5
		3. Undertake a project study based on the concepts of sustainable development* - Module II, Module III & Module IV	G	12
3	Activities	2. One activity* each from Module II, Module III & Module IV	G	15
4	Final Presentation	A comprehensive presentation summarising the key takeaways from the course, personal reflections, and proposed future actions based on the learnings.	G	5
		Total Marks		**50**

*Can be taken from the given sample activities/projects

Evaluation Criteria:

- **Depth of Analysis**: Quality and depth of reflections and analysis in project reports and case studies.
- **Application of Concepts**: Ability to apply course concepts to real-world problems and local contexts.
- **Creativity**: Innovative approaches and creative solutions proposed in projects and reflections.
- **Presentation Skills**: Clarity, coherence, and professionalism in the final presentation.

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Develop the ability to apply the principles of engineering ethics in their professional life.	**K3**
CO2	Develop the ability to exercise gender-sensitive practices in their professional lives	**K4**
CO3	Develop the ability to explore contemporary environmental issues and sustainable practices.	**K5**
CO4	Develop the ability to analyse the role of engineers in promoting sustainability and climate resilience.	**K4**
CO5	Develop interest and skills in addressing pertinent environmental and climate-related challenges through a sustainable engineering approach.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1						3	2	3	3	2		2
CO2		1				3	2	3	3	2		2
CO3						3	3	2	3	2		2
CO4		1				3	3	2	3	2		2
CO5						3	3	2	3	2		2

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Ethics in Engineering Practice and Research	Caroline Whitbeck	Cambridge University Press & Assessment	2nd edition & August 2011
2	Virtue Ethics and Professional Roles	Justin Oakley	Cambridge University Press & Assessment	November 2006
3	Sustainability Science	Bert J. M. de Vries	Cambridge University Press & Assessment	2nd edition & December 2023
4	Sustainable Engineering Principles and Practice	Bhavik R. Bakshi,	Cambridge University Press & Assessmen	2019
5	Engineering Ethics	M Govindarajan, S Natarajan and V S Senthil Kumar	PHI Learning Private Ltd, New Delhi	2012
6	Professional ethics and human values	RS Naagarazan	New age international (P) limited New Delhi	2006.
7	Ethics in Engineering	Mike W Martin and Roland Schinzinger,	Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi	4" edition, 2014

Suggested Activities/Projects:

Module-II

- Write a reflection on a local environmental issue (e.g., plastic waste in Kerala backwaters or oceans) from different ethical perspectives (anthropocentric, biocentric, ecocentric).
- Write a life cycle analysis report of a common product used in Kerala (e.g., a coconut, bamboo or rubber-based product) and present findings on its sustainability.
- Create a sustainability report for a local business, assessing its environmental, social, and economic impacts

- Presentation on biodiversity in a nearby area (e.g., a local park, a wetland, mangroves, college campus etc) and propose conservation strategies to protect it.
- Develop a conservation plan for an endangered species found in Kerala.
- Analyze the green spaces in a local urban area and propose a plan to enhance urban ecology using native plants and sustainable design.
- Create a model of a sustainable urban landscape for a chosen locality in Kerala.

Module-III

- Study a local water body (e.g., a river or lake) for signs of pollution or natural flow disruption and suggest sustainable management and restoration practices.
- Analyse the effectiveness of water management in the college campus and propose improvements - calculate the water footprint, how to reduce the footprint, how to increase supply through rainwater harvesting, and how to decrease the supply-demand ratio
- Implement a zero waste initiative on the college campus for one week and document the challenges and outcomes.
- Develop a waste audit report for the campus. Suggest a plan for a zero-waste approach.
- Create a circular economy model for a common product used in Kerala (e.g., coconut oil, cloth etc).
- Design a product or service based on circular economy and degrowth principles and present a business plan.
- Develop a plan to improve pedestrian and cycling infrastructure in a chosen locality in Kerala

Module-IV

- Evaluate the potential for installing solar panels on the college campus including cost-benefit analysis and feasibility study.
- Analyse the energy consumption patterns of the college campus and propose sustainable alternatives to reduce consumption - What gadgets are being used? How can we reduce demand using energy-saving gadgets?
- Analyse a local infrastructure project for its climate resilience and suggest improvements.
- Analyse a specific environmental regulation in India (e.g., Coastal Regulation Zone) and its impact on local communities and ecosystems.
- Research and present a case study of a successful sustainable engineering project in Kerala/India (e.g., sustainable building design, water management project, infrastructure project).
- Research and present a case study of an unsustainable engineering project in Kerala/India highlighting design and implementation faults and possible corrections/alternatives (e.g., a housing complex with water logging, a water management project causing frequent floods, infrastructure project that affects surrounding landscapes or ecosystems).

SEMESTER S4

ANALOG CIRCUITS AND SIMULATION LAB

Course Code	PCAEL407	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Lab

Course Objectives:

1. To design analog circuits using discrete components and to implement them
2. To simulate analog circuits using simulation software tools

Expt. No.	Part A Experiments using Discrete Components(Minimum SIX Experiments mandatory)
1	RC integrating and differentiating circuits (Transient analysis with different inputs and frequency response)
2	Clipping and clamping circuits
3	Astable / Monostable / BistableMultivibrator circuit
4	RC coupled CE amplifier -Frequency response characteristics
5	Cascade amplifier – gain and frequency response
6	MOSFET amplifier (CS – Frequency response characteristics)
7	Feedback amplifiers (Current series, voltage series)- gain and frequency response
8	Low frequency oscillators – RC phase shift or Wien Bridge
9	Power amplifiers (transformerless) – Class B and Class AB
10	Series voltage regulator using BJT
Part B Simulation Experiments (Minimum EIGHT Experiments Mandatory) The experiments shall be conducted using open tools such as QUCS, KiCad or variants of SPICE	
11	RC integrating and differentiating circuits (Transient analysis with different inputs and frequency response)
12	Clipping and clamping circuits

13	Astable, Monostable and BistableMultivibrator circuits
14	RC coupled CE amplifier -Frequency response characteristics
15	Cascade amplifier – gain and frequency response
16	MOSFET amplifier (CS – Frequency response characteristics)
17	Feedback amplifiers (Current series, voltage series)- gain and frequency response
18	Low frequency oscillators – RC phase shift and Wien Bridge
19	Power amplifiers (transformerless) – Class B and Class AB
20	Series voltage regulator using BJT

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	**15**	**10**	**10**	**5**	**50**

- ***Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.***
- ***Endorsement by External Examiner:*** *The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Design and implement basic analog circuits using discrete components	**K3**
CO2	Familiarize various simulation tools	**K2**
CO3	Design and simulate the functioning of basic analog circuits using simulation tools	**K3**
CO4	Effectively troubleshooting a given circuit and to analyze it	**K4**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

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

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electronic Devices and Circuit Theory	Robert Boylested and L. Nashelsky	Pearson	11/e,2017
2	Microelectronic circuits	Sedra A S. and K. C. Smith	Oxford University Press	6/e,2013
3	Electronic Devices and Circuits	David A Bell	Oxford University Press	5/e,2008

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Practical Electronics for Inventors	Scherz, P and Monk , S	MGH	4e 2016
2	Integrated Electronics	Millman J. and C. Halkias	McGraw Hill	2/e, 2010

Video Links (NPTEL, SWAYAM…)	
	Link ID
NPTEL	https://archive.nptel.ac.in/courses/108/106/108106084/ https://ae-iitr.vlabs.ac.in/

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. **Procedure/Preliminary Work/Design/Algorithm (10 Marks)**

    - Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
    - Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
    - Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
    - Creativity and logic in algorithm or experimental design.

2. **Conduct of Experiment/Execution of Work/Programming (15 Marks)**

    - Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. **Result with Valid Inference/Quality of Output (10 Marks)**

    - Accuracy of Results: Precision and correctness of the obtained results.
    - Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. **Viva Voce (10 Marks)**

    - Ability to explain the experiment, procedure results and answer related questions
    - Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. **Record (5 Marks)**

    - Completeness, clarity, and accuracy of the lab record submitted

SEMESTER S4

MICROCONTROLLERS LAB

Course Code	**PCECL408**	**CIE Marks**	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	PCECL308-Logic Circuit Design Lab	**Course Type**	Lab

Course Objectives:

1. To learn Microcontroller Programming using Assembly and C language

2. To learn Microcontroller interfaces to various modules

3. To learn any advanced microcontrollers like ARM or higher.

4. To learn Embedded System Design

Expt. No.	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)
7	Time delay generation and relay interface.
8	Display (LED/Seven segments/LCD) and keyboard interface.
9	ADC interface.
10	DAC interface with waveform generation.
11	Stepper motor and DC motor interface.
	PART C - Interface with Advanced Microcontroller using C language (Min 3 has to be completed)
12	PWM generation for DC motor control.
13	Object/Visitor Counter.

14	UART interface to Bluetooth.
15	SPI/I2C interface to display.
16	Real-time clock.

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	**15**	**10**	**10**	**5**	**50**

- ***Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.***
- ***Endorsement by External Examiner:*** *The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Develop 8051 Microcontroller programs	**K4**
CO2	Design and implement various interfaces to the 8051 Microcontroller	**K4**
CO3	Design and implement an Embedded System using a 8051 microcontroller	**K4**
CO4	Design and implement an Embedded System using an ARM processor	**K4**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	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

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	The 8051 Microcontroller and Embedded Systems Using Assembly and C	Muhammad Ali Mazidi Janice GillispieMazidi Rolin D. McKinlay	Printice Hall -Inc	Second, 2007
2	The 8051 Microcontroller Architecture, Programming and Applications	Kenneth J Ayala Dhananjay V Gadre	Cengage Learning	2010

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	8051 Hardware Description	Datasheet	Intel Corporation	1992
2	Microprocessors and Microcontrollers	Lyla B. Das	Pearson Education	2011
3	ARM System-on-Chip Architecture	Steve Furber	Addison-Wesley Educational Publishers Inc	2000
4	System-on-Chip Design with Arm(R) Cortex(R)-M Processors	Joseph Yiu	ARM Education Media	2019

Video Links (NPTEL, SWAYAM…)	
NPTEL course I	Microprocessors and Microcontrollers - https://nptel.ac.in/courses/106108100
NPTEL course II	Microcontrollers and Applications - https://nptel.ac.in/courses/117104072
NPTEL course III	Embedded System Design With ARM - https://onlinecourses.nptel.ac.in/noc22_cs93

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

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

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted