

SEMESTER 3

APPLIED ELECTRONICS & INSTRUMENTATION

SEMESTER S3
MATHEMATICS FOR ELECTRICAL SCIENCE AND PHYSICAL
SCIENCE – 3

(Common to B & C Groups)

Course Code	GYMAT301	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hr 30 Mins
Prerequisites (if any)	Basic knowledge in complex numbers.	Course Type	Theory

Course Objectives:

1. To introduce the concept and applications of Fourier transforms in various engineering fields.
2. To introduce the basic theory of functions of a complex variable, including residue integration and conformal transformation, and their applications

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fourier Integral, From Fourier series to Fourier Integral, Fourier Cosine and Sine integrals, Fourier Cosine and Sine Transform, Linearity, Transforms of Derivatives, Fourier Transform and its inverse, Linearity, Transforms of Derivative. (Text 1: Relevant topics from sections 11.7, 11.8, 11.9)	9
2	Complex Function, Limit, Continuity, Derivative, Analytic functions, Cauchy-Riemann Equations (without proof), Laplace's Equations, Harmonic functions, Finding harmonic conjugate, Conformal mapping, Mappings of $w = z^2$, $w = e^z$, $w = \frac{1}{z}$, $w = \sin z$. (Text 1: Relevant topics from sections 13.3, 13.4, 17.1, 17.2, 17.4)	9

3	Complex Integration: Line integrals in the complex plane (Definition & Basic properties), First evaluation method, Second evaluation method, Cauchy's integral theorem (without proof) on simply connected domain, Independence of path, Cauchy integral theorem on multiply connected domain (without proof), Cauchy Integral formula (without proof). (Text 1: Relevant topics from sections 14.1, 14.2, 14.3)	9
4	Taylor series and Maclaurin series, Laurent series (without proof), Singularities and Zeros – Isolated Singularity, Poles, Essential Singularities, Removable singularities, Zeros of Analytic functions – Poles and Zeros, Formulas for Residues, Residue theorem (without proof), Residue Integration- Integral of Rational Functions of $\cos\theta$ and $\sin\theta$. (Text 1: Relevant topics from sections 15.4, 16.1, 16.2, 16.3, 16.4)	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	Determine the Fourier transforms of functions and apply them to solve problems arising in engineering.	K3
CO2	Understand the analyticity of complex functions and apply it in conformal mapping.	K3
CO3	Compute complex integrals using Cauchy's integral theorem and Cauchy's integral formula.	K3
CO4	Understand the series expansion of complex function about a singularity and apply residue theorem to compute real integrals.	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
CO2	3	3	-	2	-	-	-	-	-	-	-	2
CO3	3	3	-	2	-	-	-	-	-	-	-	2
CO4	3	3	-	2	-	-	-	-	-	-	-	2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Advanced Engineering Mathematics	Erwin Kreyszig	John Wiley & Sons	10 th edition, 2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Complex Analysis	Dennis G. Zill, Patrick D. Shanahan	Jones & Bartlett	3 rd edition, 2015
2	Higher Engineering Mathematics	B. V. Ramana	McGraw-Hill Education	39 th edition, 2023
3	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	44 th edition, 2018
4	Fast Fourier Transform - Algorithms and Applications	K.R. Rao, Do Nyeon Kim, Jae Jeong Hwang	Springer	1 st edition, 2011

SEMESTER S3

ELECTRONIC DEVICES AND CIRCUITS

Course Code	PCAET302	CIE Marks	40
Teaching Hours/Week (L:T:P:R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs 30 Mins
Prerequisites (if any)	GXEST104 Introduction to Electrical and Electronics Engineering	Course Type	Theory

Course Objectives:

1. To design various analog circuits using discrete electronic devices.
2. To design and analyze different electronic circuits for various applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Wave shaping circuits - First order RC low pass and high pass filters, Differentiator and Integrator, Diode clipping circuits, Diode clamping circuits, Voltage multipliers Transistor biasing -Concept of DC and AC load lines, Types -Fixed bias circuit, Self-bias, voltage divider bias, Bias stabilization. Switching Circuits -Astable, Bistable and Monostablemultivibrators, Schmitt Trigger.	11
2	BJT amplifiers - RC coupled amplifier –Design, Voltage gain and frequency response. Small signal analysis of CE configuration - Small signal hybrid-pi model for mid and low frequency (Gain, Input and output impedance). High frequency equivalent circuits of BJT, Miller effect, Analysis of high frequency response of CE amplifier. Multistage amplifiers - Cascade and Cascode amplifiers - Design, Effect on gain and bandwidth.	11

3	MOSFETs - MOSFET as an amplifier, Biasing of p-channel and n-channel MOSFET circuits, Small signal equivalent circuit, Small signal Voltage gain, current gain, input and output impedances of CS configuration, CS stage with diode connected load. Feedback topologies - Effect of positive and negative feedback on gain, frequency response and distortion, Feedback topologies and its effect on input and output impedance, Feedback amplifier circuits using BJT in each feedback topologies (Analysis of only Voltage series feedback circuit is required)	11
4	Oscillators - Introduction, Barkhausen criterion, Classification of oscillators - RC phase shift, Wien bridge, Hartley, Colpitts and Crystal oscillators (working principle and design equations of the circuits only). Analysis of RC phase shift oscillator. Power amplifiers - Classification, Transformer coupled class A power amplifier, push pull class B and class AB power amplifiers, complementary symmetry class B and class AB power amplifiers, Class C power amplifier efficiency and distortion (no analysis required). Regulated power supplies - Load and line regulation, Series voltage regulator, shunt voltage regulator, Short circuit protection and fold back protection.	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	Design and analyze the RC circuits and BJT biasing circuits	K4
CO2	Perform small signal and high frequency analysis of BJT amplifier circuits using equivalent models	K3
CO3	Design and analyze MOSFET amplifier circuits	K4
CO4	Design and analyze feedback amplifiers and oscillators	K4
CO5	Design power amplifiers and voltage regulator circuits	K4

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	2									3
CO2	3	3	-									3
CO3	3	3	2									3
CO4	3	3	2									3
CO5	3	1	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	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	Electronic circuits, Analysis and Design	Neamen D.	McGraw Hill	3/e, 2007
2	Microelectronic Circuits – Analysis and Design	Rashid M. H	Cengage Learning	2/e, 2011
3	Fundamentals of Microelectronics	Razavi B.	Wiley	2015
4	Integrated Electronics	Millman J. and C. Halkias	McGraw Hill	2/e, 2010

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/108/106/108106084/
2	https://archive.nptel.ac.in/courses/108/106/108106084/
3	https://archive.nptel.ac.in/courses/108/106/108106084/
4	https://archive.nptel.ac.in/courses/108/106/108106084/

SEMESTER S3

TRANSDUCERS AND MEASUREMENTS

Course Code	PCAET303	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs 30 Mins
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To impart knowledge about the working principle of various types of Sensors, Transducers and measuring instruments.
2. To give an insight into the importance of error analysis and signal conditioning circuits.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction - Transducers and sensors, Classification of Transducers, Static and dynamic characteristics of transducers. Errors in measurements - Classification of errors, Error analysis, Calibration and standards. Measurement of resistance, capacitance and inductance -DC and AC bridges-Wheatstone Bridge, Kelvin's Double bridge, Maxwell's inductance bridge and Maxwell's inductance capacitance bridge, Schering bridge, Wien's bridge (Phasor diagram required).	11
2	Resistivetransducers -Potentiometers, Strain gauge, strain gauge applications-Load and torque measurement. Resistance thermometer (2 wire, 3 wire & 4 wire RTD), Thermistor, Hot wire anemometer. Inductive Transducers - Variable reluctance transducer- LVDT. Capacitive transducers - Variable air gap, Variable Area, Variable permittivity, capacitor microphone.	11

	Tacho generators and stroboscope. Designing of signal conditioning circuits (bridges) for resistive, capacitive and inductive transducers.	
3	Active transducers - Principle of operation, Constructional details, Characteristics, Types and applications of Thermocouple - cold junction compensation techniques (concepts only), Piezo electric transducers, Hall effect transducers, Photovoltaic Cell. Opto-electric Transducers - Photodiode, Phototransistor, Photoconductive cell, LDR Accelerometers - Piezoelectric, potentiometric, LVDT accelerometer, seismic type. Non-Contact type transducers - Infrared-Ultrasonic proximity sensors, Microwave Level Switches, optical level sensor, Ultrasonic level sensor, Pyrometers - Optical, Radiation pyrometers.	12
4	Measuring and Recording Instruments - Working & Torque equation of PMMC-PMMI-Electrodynamometer. Sampling Oscilloscope-Digital Storage oscilloscopes-Wave Analysers, Instrument Transformers - Current Transformer, Potential Transformer. True RMS meter- Qmeter-Strip chart recorder-XY Plotter.	10

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	Illustrate the basic concepts and performance characteristics of sensors and transducers.	K3
CO2	Analysis of bridge circuits for measuring unknown values of passive devices.	K3
CO3	Explain the principle and working of various transducers.	K2
CO4	Design various signal conditioning circuits for sensors and transducers	K3
CO5	Describe the working of various measuring and recording instruments.	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										3
CO3	3											3
CO4	3	3	3									3
CO5	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	A Course in Electrical and Electronics Measurements and Instrumentation	Shawhney A. K.	Dhanpat Rai & Sons	11th Ed., 1999.
2	Transducers in instrumentation	D. V.S. Murthy	Prentice Hall	1995

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Electronic Instrument Design	Kim R Fowler	Oxford	reprint 2015
2	Electronic Instrumentation and Measurements,	Kalsi HS	McGraw hill	4th Ed 2019.
3	Electrical Measurements and Measuring systems	Golding E W and Widdis F C	Wheeler & co	1993
4	Electronic Instrumentation and Measurements ,	David A Bell	Oxford	3rd Ed 2017

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc23_ee105/preview https://nptel.ac.in/courses/108106193
2	https://onlinecourses.nptel.ac.in/noc23_ee105/preview https://nptel.ac.in/courses/108106193
3	https://onlinecourses.nptel.ac.in/noc23_ee105/preview https://nptel.ac.in/courses/108106193
4	https://onlinecourses.nptel.ac.in/noc23_ee105/preview https://nptel.ac.in/courses/108106193

SEMESTER S3

LOGIC CIRCUIT DESIGN

Course Code	PBECT304	CIE Marks	60
Teaching Hours/Week (L:T:P:R)	3:0:0:1	ESE Marks	40
Credits	4	Exam Hours	2 Hrs 30 Mins
Prerequisites (if any)	GXEST104 Introduction to Electrical & Electronics Engineering	Course Type	Theory

Course Objectives:

1. To understand the number systems in digital systems.
2. To introduce the basic postulates of Boolean algebra, digital logic gates and Boolean expressions
3. To design and implement combinational and sequential circuits.
4. To design and implement digital circuits using Hardware Descriptive Language like Verilog on FPGA

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to digital circuits: Review of number systems representation-conversions, Arithmetic of Binary number systems, Signed and unsigned numbers, BCD. Boolean algebra: Theorems, sum of product and product of sum - simplification, canonical forms- min term and max term, Simplification of Boolean expressions - Karnaugh map (upto 4 variables), Implementation of Boolean expressions using universal gates.	9
2	Combinational logic circuits- Half adder and Full adders, Subtractors, BCD adder, Ripple carry and carry look ahead adders, Decoders, Encoders, Code converters, Comparators, Parity generator, Multiplexers, De-multiplexers, Implementation of Boolean algebra using MUX. Introduction to Verilog HDL – Basic language elements, Basic implementation of logic gates and combinational circuits.	9

3	Sequential Circuits: SR Latch, Flip flops - SR, JK, Master-Slave JK, D and T Flip flops. Conversion of Flip flops, Excitation table and characteristic equation. Shift registers-SIPO, SISO, PISO, PIPO and Universal shift registers. Ring and Johnsons counters. Design of Asynchronous, Synchronous and Mod N counters.	9
4	Finite state machines - Mealy and Moore models, State graphs, State assignment, State table, State reduction. Logic Families: -Electrical characteristics of logic gates (Noise margin, Fan-in, Fan-out, Propagation delay, Transition time, Power -delay product) -TTL, ECL, CMOS. Circuit description and working of TTL and CMOS inverter, CMOS NAND and CMOS NOR gates.	9

Suggestion on Project Topics

Note: It is mandatory that a *course project* should be done by the students.in a group of maximum 4 members. A typical application level digital system using combinational and/or sequential logic circuit can be simulated and realized in hardware as the course project. Project should be done using Verilog HDL. The project should have interim evaluations and final evaluation which also includes a presentation and demonstration.

Steps involved in PBL:

- Selection of relevant topic
- Design and optimization of digital circuit
- Simulation
- Hardware implementation (FPGA and discrete components)

Sample project ideas:

- A random sequence generator
- Traffic light controller
- Multiplexer based person priority check in system at airport
- Waveform generator
- Object/Visitor counter
- Fast adders
- Hamming code-based parity checker
- Arithmetic Logic Unit using FPGA

At the successful completion of the project, the student is expected to attain skills to design medium complexity digital circuits using Verilog HDL and its implementation on programmable logic devices like FPGA.

Evaluation parameters:

- Relevance of the topic
- HDL coding and FPGA Implementation
- Presentation skills

**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	Apply the knowledge of digital representation of information and Boolean algebra to deduce optimal digital circuits.	K3
CO2	Design and implement combinational logic circuits, sequential logic circuits and finite state machines.	K5
CO3	Design and implement digital circuits on FPGA using hardware description language (HDL).	K5
CO4	Determine the performance of logic families with Respect to different parameters.	K2

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								3
CO2	3	3	3	3	3	3	3	3	3			3
CO3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3		2									3

Text Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Digital Fundamentals	Thomas L. Floyd	Pearson Education	11 th Edition, 2017
2	Fundamentals of Digital Logic with Verilog Design	Stephen Brown	McGraw Hill Education	2 nd Edition

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog	M Morris Mano, Michael D. Ciletti	Pearson India	6 th Edition, 2018
2	Fundamentals of Digital Circuits	A. Ananthakumar	PHI	4 th Edition, 2016
3	Introduction to Logic Circuits & Logic Design with Verilog	Brock J. LaMeres	Springer	2 nd Edition, 2019
4	Digital Design Verilog HDL and Fundamentals	Joseph Cavanagh	CRC Press	1 st Edition, 2008
5	Digital Circuits and Systems	D.V. Hall	Tata McGraw Hill	1989

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/117/106/117106086/ https://archive.nptel.ac.in/courses/106/105/106105185/
2	https://archive.nptel.ac.in/courses/117/106/117106086/ https://archive.nptel.ac.in/courses/106/105/106105185/
3	https://archive.nptel.ac.in/courses/117/106/117106086/ https://archive.nptel.ac.in/courses/106/105/106105185/
4	https://archive.nptel.ac.in/courses/117/106/117106086/ https://archive.nptel.ac.in/courses/106/105/106105185/

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 S3

INTRODUCTION TO ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Course Code	GNEST305	CIE Marks	40
Teaching Hours/Week (L:T:P:R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs 30 Mins
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Demonstrate a solid understanding of advanced linear algebra concepts, machine learning algorithms and statistical analysis techniques relevant to engineering applications, principles and algorithms.
2. Apply theoretical concepts to solve practical engineering problems, analyze data to extract meaningful insights, and implement appropriate mathematical and computational techniques for AI and data science applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to AI and Machine Learning: Basics of Machine Learning - types of Machine Learning systems-challenges in ML- Supervised learning model example- regression models- Classification model example- Logistic regression-unsupervised model example- K-means clustering. Artificial Neural Network- Perceptron- Universal Approximation Theorem (statement only)- Multi-Layer Perceptron- Deep Neural Network- demonstration of regression and classification problems using MLP.(Text-2)	11
2	Mathematical Foundations of AI and Data science: Role of linear algebra in Data representation and analysis – Matrix decomposition- Singular Value Decomposition (SVD)- Spectral decomposition- Dimensionality reduction technique-Principal Component Analysis (PCA). (Text-1)	11

3	Applied Probability and Statistics for AI and Data Science: Basics of probability-random variables and statistical measures - rules in probability- Bayes theorem and its applications- statistical estimation-Maximum Likelihood Estimator (MLE) - statistical summaries- Correlation analysis- linear correlation (direct problems only)- regression analysis- linear regression (using least square method) (Text book 4)	11
4	Basics of Data Science: Benefits of data science-use of statistics and Machine Learning in Data Science- data science process - applications of Machine Learning in Data Science- modelling process- demonstration of ML applications in data science- Big Data and Data Science. (For visualization the software tools like Tableau, PowerBI, R or Python can be used. For Machine Learning implementation, Python, MATLAB or R can be used.)(Text book-5)	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	Apply the concept of machine learning algorithms including neural networks and supervised/unsupervised learning techniques for engineering applications.	K3
CO2	Apply advanced mathematical concepts such as matrix operations, singular values, and principal component analysis to analyze and solve engineering problems.	K3
CO3	Analyze and interpret data using statistical methods including descriptive statistics, correlation, and regression analysis to derive meaningful insights and make informed decisions.	K3
CO4	Integrate statistical approaches and machine learning techniques to ensure practically feasible solutions in engineering contexts.	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	3	3								
CO2	3	3	3	3								
CO3	3	3	3	3								
CO4	3	3	3	3								
CO5	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	Introduction to Linear Algebra	Gilbert Strang	Wellesley-Cambridge Press	6 th edition, 2023
2	Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow	AurélienGéron	O'Reilly Media, Inc.	2 nd edition, 2022
3	Mathematics for machine learning	Deisenroth, Marc Peter, A. Aldo Faisal, and Cheng Soon Ong	Cambridge University Press	1 st edition. 2020
4	Fundamentals of mathematical statistics	Gupta, S. C., and V. K. Kapoor	Sultan Chand & Sons	9 th edition, 2020
5	Introducing data science: big data, machine learning, and more, using Python tools	Cielen, Davy, and Arno Meysman	Simon and Schuster	1 st edition, 2016

Reference Books				
1	Data science: concepts and practice	Kotu, Vijay, and BalaDeshpande	Morgan Kaufmann	2 nd edition, 2018
2	Probability and Statistics for Data Science	Carlos Fernandez-Granda	Center for Data Science in NYU	1 st edition, 2017
3	Foundations of Data Science	Avrim Blum, John Hopcroft, and Ravi Kannan	Cambridge University Press	1 st edition, 2020
4	Statistics For Data Science	James D. Miller	Packt Publishing	1 st edition, 2019
5	Probability and Statistics - The Science of Uncertainty	Michael J. Evans and Jeffrey S. Rosenthal	University of Toronto	1 st edition, 2009
6	An Introduction to the Science of Statistics: From Theory to Implementation	Joseph C. Watkins	chrome-extension://efaidnbmnnnibpcajpcgclefindmkaj/https://www.math.arizona	Preliminary Edition.

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/106/106/106106198/
2	https://archive.nptel.ac.in/courses/106/106/106106198/ https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/resources/lecture-29-singular-value-decomposition/
3	https://ocw.mit.edu/courses/18-650-statistics-for-applications-fall-2016/resources/lecture-19-video/
4	https://archive.nptel.ac.in/courses/106/106/106106198/

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 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	6
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, Piyali Ghosh and Chodhury	Tata McGraw Hill,	2015
2	Engineering Economy	H. G. Thuesen, W. J. Fabrycky	PHI	1966
3	Engineering Economics	R. Pancerselvam	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	6

	stereotypes, Gender disparity and discrimination in education , 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	6

	mitigate, adapt and build resilience to climate change. Environmental 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.	
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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 & Assessment	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 S3

TRANSDUCERS AND MEASUREMENTS LAB

Course Code	PCAEL307	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0-0-3-0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs 30 Mins
Prerequisites (if any)	GXESL106 Basic Electrical and Electronics Engineering Workshop	Course Type	Lab

Course Objectives:

1. Familiarize the students with various types of sensors and transducers.
2. Enable students to select and design suitable instruments to meet requirements of various industrial applications

Expt. No.	Experiments
	PART A (Minimum 9 experiments are mandatory) <i>Experiments with '*' are mandatory and must be designed using discrete components and implemented on a breadboard.</i>
1	Characteristics of Strain gauge and Load cell.
2	Characteristics of LVDT
3	Characteristics of LDR.
4	Characteristics of Thermistor and RTD
5	Characteristics of Thermocouple
6	Measurement of speed using Opto Coupler/Stroboscope*
7	Characteristics of Hall Effect transducer
8	Calibration of Pressure Gauge using Dead Weight Tester
9	Level measurement using Resistive / Capacitive transducers *
10	Pressure measurement using U-tube manometer
11	Measurement of frequency and phase using Lissajous patterns
12	Measurement of displacement using inductive / capacitive transducer*
13	Automatic street light (230V bulb and relay) *

	Part B (Minimum 4 experiments are mandatory)
<i>Experiments shall be done using Python/MATLAB/SciLab/ LabVIEW with Microcontroller/Arduino as the interfacing unit</i>	
1	Measurement of temperature and humidity
2	Measurement of the level in a water tank
3	Measurement of pressure
4	Wind velocity measurement
5	Realization of Maxwell's Bridge
6	Realization of Wheatstone's bridge

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	Make use of basic transducers for the measurement of physical variables like pressure, temperature etc.	K4
CO2	Implement sensor-based measurement systems using modern tools	K4
CO3	Effectively troubleshoot a given circuit and 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	2						3			3
CO2	3	3	2		3				3			3
CO3	3	3	2						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 Instrument Design	Kim R Fowler	Oxford	reprint 2015
2	Electronic Instrumentation and Measurements,	Kalsi HS	McGraw hill	4th Ed 2019.
3	Electronic Instrumentation and Measurements ,	David A Bell	Oxford	3rd Ed 2017

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 S3

LOGIC CIRCUIT DESIGN LABORATORY

Course Code	PCECL308	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)	Nil	Course Type	Lab

Course Objectives:

1. Familiarise the students with the Digital Logic Design through the implementation of Logic Circuits.
2. Familiarise the students with the HDL based Digital Design and FPGA boards.

Details of Experiment

Expt. No	Part A – List of Experiments using digital components (Any Six experiments mandatory)
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, Realization of Mod N Counter
6	Synchronous Counter: Realization of 4-bit up/down counter, Realization of Mod-N counters
7	Ring counter and Johnson Counter.
8	Realization of counters using IC's (7490, 7492, 7493).
9	Realization of combinational circuits using MUX & DEMUX, using ICs (74150, 74154)
10	Sequence Generator / Detector

Expt. No	Part B – Simulation Experiments (Any Six experiments mandatory) The experiments shall be conducted using Verilog and implementation using small FPGA
1.	Realization of Logic Gates and Familiarization of FPGAs (a) Familiarization of a small FPGA board 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 any of the 3 modeling styles (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 coutners (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 any logic function
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-flops 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-flops in the previous experiment, implement and test them on the FPGAboard.
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 ouput ports for connection to the display.

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 Exam	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

Mandatory requirements for ESE:

- 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 the student will be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Design and demonstrate the functioning of various combinational and sequential circuits using ICs	K3
CO2	Apply an industry compatible hardware description language to implement digital circuits	K3
CO3	Implement digital circuits on FPGA boards and connect external hardware to the boards	K3
CO4	Function effectively as an individual and in a team to accomplish the given task.	K2

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	3	2					3			3
CO2	3	1	1	3	3				3	1		3
CO3	3	1	1	3	3				3	1		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	Verilog HDL Synthesis: A Practical Primer	J. Bhasker	B. S. Publications	2001
2	Fundamentals of Logic Design	Roth C.H	Jaico Publishers	5th Edition 2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Verilog HDL :A guide to digital design and synthesis	Palnitkar S	Prentice Hall	2003 2nd Edn.

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/108/105/108105113/
2	https://onlinecourses.nptel.ac.in/noc24_cs61/preview

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 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	9 th edition, 2016
2	Probability, Statistics and Random Processes	T Veerarajan	The McGraw-Hill	3 rd 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.	4 th edition, 2002
2	Introduction to Probability and Statistics for Engineers and Scientists	Ross, S. M.	Academic Press	6 th edition, 2020
3	Probability and Random Processes	Palaniammal, S.	PHI Learning Private Limited	3 rd edition, 2015
4	Introduction to Probability	David F. Anderson, Timo, Benedek	Cambridge	1 st 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.	
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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
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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	5 th 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	7th 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
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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	4 th Edition, 2022
2	Data Structures: A Pseudocode Approach with C	Richard F. Gilberg	Cengage India Private Limited	2 nd 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	2 nd Edition, 2002
2	An Introduction to Data Structures with Application	J P Trembley and P Sorenson	McGraw Hill	2 nd Edition, 2017
3	Data Structures and Algorithms	Aho A. V., J. E. Hopcroft and J. D. Ullman	Pearson Education	1 st 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):

<i>Attendance</i>	<i>Internal Ex</i>	<i>Evaluate</i>	<i>Analyse</i>	<i>Total</i>
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	4 th , 2008
3	Digital Logic Applications and Design	John M Yarbrough	Cengage Learning India	1 st , 2006
4	Digital Design: With an Introduction to the Verilog HDL, VHDL, and SystemVerilog	M.Morris Mano and Michel.D.Ciletti,	Pearson	6 th , 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	1 st , 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	3 rd 2009
6	Digital System Design Using VHDL	Rishabh Anand	Khanna Publishing	1 st , 2013
7	Digital System Design Using VHDL	Lizy Kurian John, Charles H. Roth	Cengage	1 st , 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, Receiver Operating Characteristic Curve (ROC), Area Under Curve (AUC).	9

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

Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Internal Ex</i>	<i>Evaluate</i>	<i>Analyse</i>	<i>Total</i>
5	15	10	10	40

Criteria for Evaluation (Evaluate and Analyse): 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	2 nd Edition, 2010
2	Data Mining and Analysis: Fundamental Concepts and Algorithms	Mohammed J. Zaki and Wagner MeiraJr	Cambridge University Press	1 st Edition, 2014
3	Python Data Science Handbook	Jake VanderPlas	O'Reilly Media	2 nd 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	2 nd 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, Piyali Ghosh 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.	
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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 & Assessment	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 / Bistable Multivibrator 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 Bistable Multivibrator 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

SEMESTER 5

APPLIED ELECTRONICS AND INSTRUMENTATION

SEMESTER S5

CONTROL SYSTEM THEORY

Course Code	PCAET501	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)	GYMAT101- Mathematics for Electrical Science and Physical Science - 1	Course Type	Theory

Course Objectives:

1. To study the elements of control system, modelling and perform stability analysis of systems.
2. To understand the state variable analysis method.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	System modelling - Introduction to control systems, Classification of control systems. Open loop and closed loop control systems, Transfer function, Poles and Zeros, Mathematical modelling of electrical, mechanical and electromechanical system, Block diagram reduction techniques, Signal flow graph, Mason's gain formula.	11
2	Time domain analysis - Standard test signals, Response of first and second order systems to impulse and step inputs. Time domain specifications - Delay time, rise time, peak time, maximum percentage overshoot and settling time. Steady state response - Steady state error- Static & Dynamic error coefficients. Concept of stability: Routh-Hurwitz method for stability analysis.	11

3	Stability analysis in time domain Root locus - Construction of root locus, Effect of addition of poles and zeros. Frequency domain analysis - Frequency response, Frequency domain specifications, Stability in the frequency domain, Nyquist stability criterion, Stability analysis using Polar and Bode plots, relative stability, Gain margin and phase margin.	11
4	State variable analysis: State space representation of Continuous Time systems. Transfer function from State Variable Representation, Solution of state equations, state transition matrix, Controllability and Observability - Kalman's Test.	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	Analyze the systems using transfer function approach	K3
CO2	Conduct time domain analysis and steady state analysis of systems	K3
CO3	Conduct stability analysis of systems using time domain and frequency domain methods	K3
CO4	Analyze control systems using state space techniques	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	3			2							3
CO2	3	3			2							3
CO3	3	3	2		2							3
CO4	3	3	2		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	Modern Control Engineering	Katsuhiko Ogata	Pearson Education	5/e, 2009
2	Control Systems: Principles and design	M. Gopal	McGraw Hill Education India Education	4/e, 2012
3	Automatic Control systems	Benjamin C. Kuo, Farid Golnaraghi	Wiley	9/e, 2014

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automatic Control Systems (with MATLAB programs)	S. Hassan Saeed	KATSON Educational series	2013
2	Control System Engineering	Norman S Nise	Wiley	5/e, 2009
3	Modern Control Systems	Richard C Dorf and Robert H. Bishop	Pearson Education	13/e, 2016
4	Control System Engineering	I. J. Nagrath and Madan Gopal	New Age International	7/e, 2021

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/107106081
2	https://nptel.ac.in/courses/107106081
3	https://nptel.ac.in/courses/107106081
4	https://nptel.ac.in/courses/107106081

SEMESTER S5

PROCESS DYNAMICS AND CONTROL

Course Code	PCAET502	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)	-	Course Type	Theory

Course Objectives:

1. Understand the fundamental principles of process control and automation.
2. Design, implementation and optimize control strategies for various types of processes.
3. Discuss advanced control techniques and their application in industrial settings.
4. Discuss emerging technologies such as Industry 4.0 and their impact on smart manufacturing.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Process characteristics - Incentives for process control, Process Variables types and selection criteria, Process degree of freedom, The period of Oscillation and Damping, Characteristics of physical System: Resistance, Capacitive and Combination of both. Elements of Process Dynamics, Types of processes- Dead time, Single /multi capacity, self-Regulating /non-self-regulating, Interacting /non interacting, Linear/non-linear, and Selection of control action for them. Study of Liquid, Gas, Flow and Thermal Processes.	11
2	Elements of Process Control Loop - Pneumatic and electric actuators, control valves - characteristics of control valves, valve positioner - I/P and P/I converters- Electronic Controllers. Analysis of Control Loop: Steady state gain, Process gain, Valve gain, Process time constant, Variable time Constant, Transmitter gain, linearizing an equal percentage valve, Variable pressure drop. Analysis of Liquid level Control, Temperature control.	11
3	Feedback Control - Block Diagram, Control Performance Measures for standard Input Changes. Different Controllers (P, PI, PD and PID) and	11

	tuning parameters. Tuning of feedback controllers: Open loop and closed loop tuning techniques. Quarter Decay ratio response, minimal error integral criteria. Advanced Control Techniques: Cascade control, Feed forward control, feedback-feed forward control, Ratio control, Selective Control.	
4	Model Based controllers - Internal Model control, Model Predictive controller, Adaptive and Self-Tuning Controller. Computer Control of Process Plants - Centralised Control System, Distributed Control Systems- Fieldbus System-Fieldbus Types, Hierarchical Control Systems, Supervisory Control and Data Acquisition (SCADA) system- Basic concept Industry 4.0 and Smart Manufacturing - Integration of cyber-physical systems (CPS), IoT, and AI to optimize manufacturing processes.	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	Understand and apply the dynamics and characteristics of industrial processes for effective control.	K3
CO2	Analysis and design effective control loops using different components for industrial processes	K3
CO3	Design, analyze, and implement effective feedback control systems.	K3
CO4	Understand advanced control systems and applications of computer control systems	K2
CO5	Summarize advanced model-based controllers and Industry 4.0	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	3	2								2
CO2	3	3	3	2								2
CO3	3	3	3	2								2
CO4	3	2	3	2								2
CO5	3	2	3	3								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	Process Control: Modeling, Design and Simulation, 1/e	B.WayneBequette	PHI	2002
2	Automatic Process Control	Donald Eckman	Wiley Eastern Limited	2009
3	Process control Systems	F.G.Shinsky	TMH	1996
4	Principles and practice of Automatic Process Control, 3 rd edition	Carlos A. Smith, Armando B. Corripio	John Wiley & Sons,	2005
5	Process Control Instrumentation Technology, 8 th Edition	Curtis D Johnson	Pearson; 8th edition	2005
6	Process Systems Analysis and Control, 3/e	Donald H Coughnowr	Mc Graw Hill	2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Handbook of Instrumentation - Process control	B.G.Liptak	Chilton Book Company, Pennsylvania	1995
2	Computer Based Industrial Control	Krishna Kant	PHI	2010
3	Fundamentals of Process Control Theory, 3 rd Edition	Paul W. Murrill	ISA	1999
4	Chemical Process Control: An Introduction to Theory and Practice	George Stephanopoulos	Pearson	2015
5	Process Control- Designing processes and Control Systems for Dynamic performance, 2 nd ed	Thomas E Marlin	McGraw-Hill International Editions	2000
6	Industry 4.0: The Industrial Internet of Things	Alasdair Gilchrist	Apress	2019

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/103/103/103103037/
2	https://archive.nptel.ac.in/courses/103/103/103103037/
3	https://archive.nptel.ac.in/courses/103/103/103103037/
4	https://archive.nptel.ac.in/courses/103/103/103103037/

SEMESTER S5

POWER ELECTRONICS

Course Code	PCAET503	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)	PCAET302 Electronic Devices and Circuits	Course Type	Theory

Course Objectives:

1. To introduce various power semiconductor devices
2. To acquire knowledge about rectifiers, inverters & converters used in industrial applications

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Power Semiconductor Devices - Overview of power electronics applications, Power diodes and Bipolar power transistors – static and dynamic characteristics, Power MOSFET, IGBT, SCR and GTO. Protection circuits and Rectifiers - BJT and MOSFET driver circuits, Snubber circuits, Single phase and three phase diode bridge rectifiers, Single phase and three phase controlled rectifiers.	10
2	DC – DC Switch Mode Converter - Buck, Boost and Buck-Boost converters under Continuous conduction mode. Isolated Converters – Forward, Push-Pull, Half bridge, Full bridge and Flyback configurations. Switched Mode Power Supply.	9
3	DC – AC Switch Mode Inverter - Inverter topologies, Driven Inverters – Push-Pull, Half bridge and Full bridge configurations, Three phase Inverter, Basic concept of pulse width modulator.	9

4	Applications (concepts only) - DC Motor Drives, Induction Motor Drives, Residential and Industrial applications, Electric utility applications.	8
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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 =24 marks)	• 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	Illustrate the characteristics of important power semiconductor switches	K2
CO2	Apply the principle of drive circuits and rectifier circuits for power applications	K3
CO3	Design DC-DC converters and DC-AC inverters	K4
CO4	Apply the principle of power electronic drives for various applications	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										3
CO2	3	3										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	Power Electronics, 3ed (An Indian Adaptation): Converters, Applications and Design	Ned Mohan, Tore M. Undeland and William P. Robbins	Wiley	3 rd Edition, 2022
2	Power Electronics Essentials and Applications	Umanand L	Wiley	2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Power Electronics: Devices, Circuits, and Applications	M H Rashid	Pearson Education	4 th Edition, 2017
2	Power Electronics	Daniel W. Hart	McGraw Hill	2010
3	Power Electronics	P S Bimbhra	KHANNA	7 th Edition, 2022

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/108105066 https://archive.nptel.ac.in/courses/108/102/108102145/
2	https://nptel.ac.in/courses/108105066 https://archive.nptel.ac.in/courses/108/102/108102145/
3	https://nptel.ac.in/courses/108105066 https://archive.nptel.ac.in/courses/108/102/108102145/
4	https://nptel.ac.in/courses/108105066 https://archive.nptel.ac.in/courses/108/102/108102145/

SEMESTER S5

DIGITAL SIGNAL PROCESSING

Course Code	PBECT504	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)	PCECT402 Signals and Systems	Course Type	Theory

Course Objectives:

1. To describe signals mathematically and understand how to perform mathematical operations on signals
2. To gain knowledge of Digital filters

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Review of sampling, Z-Transform and DTFT The Discrete Fourier Transform - DFT as a linear transformation (Matrix Relation), IDFT, Properties of DFT and examples (proof not necessary). Circular convolution, linear convolution using circular convolution, Filtering of long data sequences, overlap save and overlap add methods. Frequency Analysis of Signals using the DFT (concept only required)	9
2	Design of FIR Filters - Symmetric and Anti-symmetric FIR Filters, Design of linear phase FIR filters using Window methods (rectangular, Hamming and Hanning). Design of IIR Digital Filters from Analog Filters (Butterworth), IIR Filter Design by Impulse Invariance, and Bilinear Transformation, Frequency Transformations in the Analog Domain.	9
3	Structures for the realization of Discrete-Time Systems - Block diagram and signal flow graph representations of filters.	9

	FIR Filter Structures - Linear structures, Direct Form. IIR Filter Structures - Direct Form, Transposed Form, Cascade Form and Parallel Form. Multi-rate Digital Signal Processing - Decimation and Interpolation (Time domain and Frequency Domain Interpretation), Anti- aliasing and anti-imaging filter.	
4	Efficient Computation of DFT - Fast Fourier Transform and computational advantage over DFT, Radix-2 Decimation in Time FFT Algorithm. Computer architecture for signal processing - Harvard Architecture, pipelining, MAC, Introduction to TMS320C67xx digital signal processor, Functional Block Diagram. Finite word length effects in DSP systems - Introduction, fixed-point and floating-point DSP arithmetic, ADC quantization noise.	9

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	To learn fundamental properties and relations relevant to DFT and solve basic problems involving DFT-based filtering methods.	K1
CO2	To design linear phase FIR filters and IIR filters of different specifications.	K3
CO3	To realise the various FIR and IIR filter structures for a given system function.	K3
CO4	To compute DFT efficiently using FFT method and to understand the architecture of a DSP processor.	K2

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	3		3							2
CO3	3	3	3		3							2
CO4	3	3	2		3							2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Digital Signal Processing using Matlab	Vinay K. Ingle, John G. Proakis	Cengage Learning	3 rd Ed., 2011
2	Think DSP: Digital Signal Processing using Python	Allen B. Downey	Green Tea Press	2012
3	Discrete-Time Signal Processing	Alan V Oppenheim, Ronald W. Schaffer	Pearson Education	3 rd Ed., 2014

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Digital Signal Processing	Shaila D. Apte	Wiley	2nd Ed, 2019
2	Digital Signal Processing: A Computer based Approach	Mitra S. K.	McGraw Hill	4 th Ed., 2014
3	Digital Signal Processing: A Practical Approach	Ifeachor E. C., Jervis B. W.	Pearson Education	2 nd Ed., 2009
4	Digital Signal Processing	Salivahanan S.	McGraw Hill	4 th Ed., 2019

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/117102060 https://nptel.ac.in/courses/108105055
2	https://nptel.ac.in/courses/117102060 https://nptel.ac.in/courses/108105055
3	https://nptel.ac.in/courses/117102060 https://nptel.ac.in/courses/108105055
4	https://nptel.ac.in/courses/117102060 https://nptel.ac.in/courses/108105055

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 S5

DATA COMMUNICATION

Course Code	PEAET521	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)	-	Course Type	Theory

Course Objectives:

1. Equip students with basic knowledge in data communication networks
2. Get acquainted with the design constraints of different types of data networks
3. Familiarize with packet routing methodologies in modern communication networks
4. Acquire knowledge about various application-level interfaces to data networks

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Layered Tasks in Communication, OSI model, Digital signals, Transmission impairments, Performance measures, Transmission modes.	7
2	Physical Layer - Guided and unguided media, different switched networks. Data Link Layer: Framing, Flow and Error Control, HDLC, PPP, random and controlled access, IEEE standards for wired and wireless LAN.	11
3	Network Layer - Logical addressing, Internet Protocol, unicast and multicast routing protocols, ICMP. Transport Layer: UDP, TCP, SCTP, Congestion control	11
4	Application Layer - Name space, DNS, remote logging, SMTP, POP, FTP, HTTP, SNMP, RTP, Security in Internet	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)	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	Describe the different data communication aspects and analyze communication networks using well defined performance metrics	K4
CO2	Explain the various physical layer and media access control standards in the data communication	K2
CO3	Identify various packet routing and congestion control techniques in large communication networks.	K2
CO4	Recognize the methodologies developed to interact with the present communication technologies	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	2									3
CO2	3		2									3
CO3	3		2									3
CO4	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	Data Communications and Networking	Behrouz A. Forouzan	McGraw Hill Education	5 th , 2017
2	TCP/IP Protocol Suite	Behrouz A. Forouzan	McGraw Hill Education	4 th , 2017
3	Computer Networks	Tanenbaum	Pearson Education	6 th , 2022
4	Data and Computer Communication	William Stallings	Pearson Education	10 th , 2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Data Networks	D. P. Bertsekas & R. Gallager	Prentice Hall	2 nd , 1992
2	High Performance Communication Networks	J. Walrand & P. Araiya	Morgan Kaufmann	2 nd , 2004
3	Computer Networking: A Top Down Approach Featuring Internet	J. K. Kurose & K. W. Ross	Pearson Education	8 th , 2022
4	Communication Networking:	Anurag Kumar, D.	Morgan Kaufmann	1 st , 2004

	An Analytical Approach	Manjunath, Joy Kur		
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Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/106105082
2	https://nptel.ac.in/courses/106105082
3	https://nptel.ac.in/courses/106105082
4	https://nptel.ac.in/courses/106105082

SEMESTER S5

MODERN PROCESSOR ARCHITECTURE

Course Code	PEAET522	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)	PBECT404 Microcontrollers	Course Type	Theory

Course Objectives:

1. To understand the various aspects of processor architecture
2. To illustrate the memory hierarchy in processors
3. To analyze thread level parallelism and multiprocessor architectures

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to computer architecture Classes of computers, defining computer architecture, Introduction to RISC and CISC architectures, Classification of instruction set architectures, basics of performance measurements. Basic parallel processing techniques – instruction level, thread level and process level. Classification of parallel architectures. Introduction to Graphical Processing Unit (GPU).	9
2	Pipelined Processors and Super Scalar Organization Pipelining fundamentals – Pipelined design, concept of Arithmetic pipelining and Instruction pipelining. Basic concept of Deeply pipelined processors. Super Scalar Organization – Limitations of Scalar pipelines, Basics concepts of parallel, diversified and dynamic pipelines. Superscalar pipeline overview – instruction fetch, decode, dispatch, execute, completion and retiring.	9

3	Memory Hierarchy Computer system overview, Concept of latency and bandwidth. Memory Hierarchy – Introduction, levels in modern Memory hierarchy, concept of temporal and spatial locality, DRAM Technology. Cache memories – cache hit, cache miss and hit ratio, types of cache mapping – direct, associative and set associative. Virtual Memory systems – Demand paging, memory protection. Overview of memory hierarchy implementations.	9
4	Thread-Level Parallelism Introduction to thread level parallelism and Multiprocessor Systems, Basic architecture of Centralised Shared Memory multiprocessor and distributed memory multiprocessor, concept of Cache coherence problem, basic schemes for enforcing coherence – Snooping coherence protocol. Introduction to Distributed Shared Memory and Directory-Based Coherence, directory-Based cache Coherence protocol	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 basic of computer architecture and parallel processing techniques	K2
CO2	Apply concepts of parallel processing to develop pipelined and superscalar architectures	K3
CO3	Demonstrate the different memory systems in modern processors	K2
CO4	Analyse thread level parallelism and multi-processor architectures	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
CO2	3	2	3	2								3
CO3	3	2	3									3
CO4	3	2	3	2								3

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computer Architecture: A Quantitative Approach	John L. Hennessy, David A. Patterson	Morgan Kaufmann	6th Edition, 2018
2	Modern Processor Design: Fundamentals of Superscalar Processors	John Paul Shen, Mikko H. Lipasti	Waveland Press	2013

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computer Organization & Architecture: Design for performance	William Stallings	Pearson	11th Edition, 2022
2	Computer Organization and Embedded Systems	Carl Hamacher, Zvonko Vranesic, Safwat Zaky and Naraig Manjikian	McGraw Hill	6th Edition, 2023
3	Computer Architecture	Behrooz Parhami	Oxford University Press	2012
4	Parallel Computer Organization and Design	Michel Dubois, Murali Annavaram and Per Stenstroem	Cambridge University Press	2012
5	Computer Architecture: Complexity and Correctness	Silvia M. Mueller and Wolfgang J. Paul	Springer	2010
6	Computer Architecture and Implementation	Harvey G. Cragon	Cambridge University Press	2000

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/106105033
2	https://nptel.ac.in/courses/106105033
3	https://nptel.ac.in/courses/106105033
4	https://nptel.ac.in/courses/106105033

SEMESTER S5

SOFT COMPUTING

Course Code	PEAET523	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)	None	Course Type	Theory

Course Objectives:

1. To understand the fundamentals of Genetic Algorithms and hybrid systems.
2. To familiarize various techniques of soft computing like fuzzy logic, neural networks and genetic algorithm.
3. To give an overview of the concepts and terminologies in fuzzy logic systems.
4. To acquire knowledge on artificial neural networks with its advantages and applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Soft Computing. Difference between Hard Computing & Soft Computing. Applications of Soft Computing. Artificial Neurons vs Biological Neurons. Basic models of artificial neural networks – Connections, Learning, Types of activation functions. McCulloch and Pitts Neuron. Realization of logic gates using McCulloch-Pitts neuron model.	9
2	Perceptron Networks– Learning rule, Supervised and Unsupervised learning, Training and testing algorithm. Adaptive Linear Neuron– Architecture, Training and testing algorithm. Back propagation Network – Architecture, Training and testing algorithm. Fuzzy sets – properties, operations on fuzzy set. Fuzzy membership functions.	9

3	Methods of membership value assignments – intuition, inference, Rank Ordering. Fuzzy relations– operations on fuzzy relation. Fuzzy Propositions. Fuzzy implications. Defuzzification– Lamda cuts, Defuzzification methods. Fuzzy Inference Systems - Mamdani and Sugeno types. Fuzzy Logic Control systems. Applications of Neural Networks -Neural Networks in Control Systems.	9
4	Concepts of genetic algorithm. Operators in genetic algorithm - coding, selection, cross over, mutation. Stopping condition for genetic algorithm. Rank method–Rank space method AI search algorithm. Neuro-fuzzy hybrid systems. Genetic – neuro hybrid systems. Integration of neural networks, fuzzy logic and genetic algorithms.	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	Describe soft computing techniques and the basic models of Artificial Neural Network	K2
CO2	Solve practical problems using neural networks	K3
CO3	Illustrate the operations, model and applications of fuzzy logic	K3
CO4	Illustrate the concepts of Genetic Algorithm	K3
CO5	Describe the concepts and the need for using hybrid soft computing approaches	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	3	2								3
CO3	3	2	3	2								3
CO4	3	2	3	2								3
CO5	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	Principles of Soft Computing	S.N.Sivanandam and S.N. Deepa	John Wiley & Sons.	3 rd Edition, 2018
2	Multi-objective Optimization using Evolutionary Algorithms	Kalyanmoy Deb,	John Wiley & Sons.	1st Edition, 2008
3	Fundamentals of Neural Networks: Architecture, Algorithms and Applications	Laurene Fausett	Pearson	1 st Edition, 2004

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fuzzy Logic with Engineering Applications	Timothy J Ross	John Wiley & Sons	3 rd Edition, 2011
2	Neural Networks, Fuzzy Logic & Genetic Algorithms Synthesis and Applications	T.S.Rajasekaran, G.A.Vijayalakshmi Pai	Prentice-Hall India	2 nd Edition, 2017
3	Neural Networks- A Comprehensive Foundation	Simon Haykin	Pearson Education	2 nd Edition, 2003
4	Fuzzy Set Theory & Its Applications	Zimmermann H. J	Springer	3 rd Edition, 1996
5	<i>Neural Fuzzy Systems – A neuro fuzzy synergism to intelligent systems</i>	Chin –Teng Lin and C.S. George Lee	Prentice Hall International	1 st Edition, 1996

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/106/105/106105173/
2	https://archive.nptel.ac.in/courses/106/105/106105173/
3	https://archive.nptel.ac.in/courses/106/105/106105173/
4	https://archive.nptel.ac.in/courses/106/105/106105173/

SEMESTER S5

OPTIMIZATION TECHNIQUES

Course Code	PEAET524	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)	GYMAT101 Mathematics for Electrical Science and Physical Science-1	Course Type	Theory

Course Objectives:

1. To understand and formulate various optimization problems.
2. To solve linear and non-linear optimization problems.
3. To understand the modern optimization techniques

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Optimization Engineering applications of optimization, mathematical formulation of an optimization problem, Transport problem as an example, Concept of convexity. Classification of optimization techniques - Constrained and Unconstrained Optimization, Global and Local Optimization, Stochastic and Deterministic Optimization. Classical Optimization - Single variable optimization, unconstrained multivariable optimisation, Multivariable optimization with Constraints (basic concept only), Karush-Kuhn-Tucker conditions.	9
2	Linear Programming Problems and Game Theory Mathematical formulation of Linear Programming Problems, Solving using Simplex method and Graphical method, Linear Programming Applications. Introduction to Game Theory, optimal solution of two person zero sum	9

	games. Basic concept of Graphical solution to games with mixed strategy	
3	Network Optimization Models and Nonlinear optimization Minimum Spanning Tree – Prim’s Algorithm. Shortest Path Problem – Dijkstra’s Algorithm Single Variable Optimization Methods - Fibonacci search method and Newton Raphson method. Multi-variable Methods - Hook-Jeeves pattern search method, Cauchy’s (steepest descent) method.	9
4	Modern Methods of Optimization Introduction to Genetic Algorithm, GA operators – Reproduction, Crossover, Mutation. Introduction to Fuzzy logic, Fuzzy sets and membership functions, Operations on Fuzzy sets, Optimization of Fuzzy Systems. Basics of Neural network based optimization.	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 and formulate various optimization problems	K2
CO2	Apply various techniques for linear and non-linear optimization problems	K3
CO3	Understand the concepts of game theory and develop solutions	K2
CO4	Use modern techniques for optimization problems	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	3	3	2		2						3
CO2	3	3	3	2		2						3
CO3	3	3	3	3		2						3
CO4	3	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	Engineering Optimization: Theory and Practice	Singiresu S. Rao	Wiley	5 th Edition, 2023
2	Operations Research: An Introduction	Hamdy A. Taha	Pearson	10 th Edition, 2019
3	Introduction to Operations Research	Frederick S. Hillier, Gerald J. Lieberman, Bodhibrata Nag, Preetam Basu	McGraw Hill	10 th Edition, 2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	An Introduction to Optimization	Edwin K. P. Chong and Stanislaw H. Zak	Wiley	4 th Edition, 2017
2	Numerical Optimization	Jorge Nocedal and Stephen J. Wright	Springer	2 nd Edition, 2006
3	Optimization for Engineering Design: Algorithms and Examples	Kalyanmoy Deb	PHI	2 nd Edition, 2012
4	Optimization in Operations Research	Ronald L. Rardin	Pearson	2 nd Edition, 2016

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/111105039
2	https://nptel.ac.in/courses/111105039
3	https://nptel.ac.in/courses/111105039
4	https://nptel.ac.in/courses/108104112

SEMESTER S5

BIOMEDICAL INSTRUMENTATION

Course Code	PEAET526	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 Objective:

1. To give a brief introduction to human physiology and various instrumentation systems for the measurement and analysis of various physiological parameters

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Biomedical Instrumentation - Block diagram, Problems encountered in biomedical measurements. Brief introduction on physiological systems of the body-Nervous, cardiovascular and respiratory systems. Sources of bioelectric potentials- resting potential, action potential. Electrode theory, Nernst equation and various types of electrodes. Bio electric signals - ECG, EEG, EMG and ERG.	9
2	ECG Measurements – Electro conduction system of the heart. Electrocardiography, electrodes and leads – Einthoven triangle, ECG machine – block diagram. Measurement of blood pressure – direct and indirect measurement – oscillometric measurement – ultrasonic method. Blood flow cardiac output, plethysmography, cardiac arrhythmia. Pace makers, defibrillators. Respiratory parameters – Spiro meter, pneumograph.	9
3	EEG and EMG Measurements – EEG instrumentation, electrode placement, EEG patterns. Muscle response – Electromyogram (EMG) – Nerve Conduction velocity measurements.	9

	Patient monitoring systems – Intensive cardiac care, bedside and central monitoring systems. Sources of electrical hazards and safety techniques.	
4	Biomedical Imaging Techniques X-rays, laser applications. Basic principle of computed tomography. Magnetic resonance imaging system and nuclear medicine system. Ultrasonic imaging system - introduction and basic principle. Color doppler systems, Holter monitoring, Endoscopy.	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	Describe the basic principles of physiological systems of human body	K2
CO2	Illustrate the design principles and development of various biomedical instruments	K3
CO3	Explain the principle of patient monitoring systems and identify safety issues related to biomedical instrumentation.	K2
CO4	Describe the applications of medical imaging techniques in biomedical instrumentation.	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			3	3					3
CO2	3		2			3	3					3
CO3	3		2		3	3	3					3
CO4	3		2		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	Medical Instrumentation Application and Design	John G. Webster, Amit J. Nimunkar	Wiley	5th edition, 2021
2	Biomedical Instrumentation And Measurements	Leslie Cromwell	Pearson Education India;	2nd edition, 2015
3	Handbook of Biomedical Instrumentation	Khandpur R.S	Tata McGraw-Hill, New Delhi, 2 Edition	2003

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Biomedical Instrumentation	M. Arumugam	Anuradha Publications	1994
2	Introduction to Biomedical Equipment Technology	Joseph J. Carr and John M. Brown	Wiley and sons, New York	2012

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/108/105/108105101/
2	https://archive.nptel.ac.in/courses/108/105/108105101/
3	https://archive.nptel.ac.in/courses/108/105/108105101/
4	https://archive.nptel.ac.in/courses/102/105/102105090/

SEMESTER - S5

VLSI SYSTEM DESIGN

Course Code	PEAET525	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)	PBECT304 Logic Circuit Design	Course Type	Theory

Course Objectives:

1. To understand the static and dynamic characteristics of CMOS circuits.
2. To design combinational and sequential logic circuits for VLSI design.
3. To understand the VLSI design flow, validation and testing.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Overview of PMOS and NMOS devices (pre-requisite). CMOS inverter – Working, Voltage transfer characteristics. Static characteristics – switching threshold and noise margin. Dynamic characteristics – Device capacitance, RC delay model, Propagation delay and power consumption.	8
2	Combinational Logic Circuits Static CMOS Design – Complimentary CMOS, Design techniques for large fan-in, Ratioed logic, basics of pass transistor logic and transmission gate logic. Dynamic CMOS Design – Basic principles, concept of Domino logic, speed and power dissipation, signal integrity issues in dynamic logic.	9
3	Sequential Logic Circuits and Arithmetic Building blocks Sequential Logic Circuits – Timing metrics for sequential circuits, static SR flip-flop, Static Multiplexer based D flip-flop and master slave configuration. Dynamic Clocked CMOS (C ² MOS) Register. Arithmetic Building blocks – Static CMOS Full Adder, 4-bit carry bypass	10

	adder, Array multiplier, carry-save multiplier, barrel shifter.	
4	VLSI Design Methodologies ASIC Design flow and FPGA design flow, Introduction to SoC Design, Challenges in VLSI Design. Basics of semi-custom and full custom design methodologies. Validation and testing – Fault Modelling, stuck at faults, Test procedure, logic testing vs memory testing, Built-in-self-test (BIST), Automatic test pattern generation (ATPG)	9

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

Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Internal Ex</i>	<i>Evaluate</i>	<i>Analyse</i>	<i>Total</i>
5	15	10	10	40

Criteria for Evaluation (Evaluate and Analyse): 20 marks

- The students should conduct all the 4 experiments mentioned below using EDA tools/ASIC Design tools like Electric, Alliance, Microwind, Glade, Cadence Synopsys, Mentor Graphics and Xilinx Vivado.
- The experiment 4 can also be carried out using FPGA design flow tools. It is required to set appropriate constraints in FPGA advanced synthesis options
- Use library files and technology files below 180 nm to carry out the experiments.

Experiment 1: Capture the schematic of CMOS inverter with load capacitance of 0.1pF and set the widths of inverter with $W_n = W_p$, $W_n = 2W_p$, $W_n = W_p/2$ and length at selected technology. Carry out the following analysis:

- Set the input signal to a pulse with rise time, fall time of 1ns and pulse width of 10ns and time period of 20ns and plot the input voltage and output voltage of designed inverter.
- From the simulation results compute t_{pHL} , t_{pLH} and t_d for all three geometrical settings of width.
- Tabulate the results of delay and find the best geometry for minimum delay CMOS inverter.

Experiment 2: Draw layout of CMOS inverter with $W_p/W_n = 40/20$, use optimum layout methods. Verify for DRC and LVS.

Also familiarise the tools available for floor planning, placement, routing and Generation of GDS II reports.

Experiment 3: Design a 2-input CMOS NAND gate having similar delay as that of CMOS inverter computed in experiment 1. Draw the schematic and analyse the delay. Also, verify the functionality of NAND gate and also find out the delay t_d for all four possible combinations of input vectors. Table the results.

Experiment 4: Write verilog code for 4-bit adder and verify its functionality using test bench. Synthesize the design by setting proper constraints and obtain the net list. From the report generated identify critical path, maximum delay, total number of cells, power requirement and total area required. Change the constraints and obtain optimum synthesis results.

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	Analyse CMOS inverter	K3
CO2	Design and analyze combinational and sequential logic circuits	K3
CO3	Describe arithmetic building blocks in VLSI.	K3
CO4	Explain the VLSI design flow and testing methodologies.	K4

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	3									3
CO2	3	3	3									3
CO3	3	3	3	2								3
CO4	3	3	3	2	3							3

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Digital Integrated Circuits: A Design perspective	Jan M. Rabaey, Anantha Chandrakasan, and Borivoje Nikolic	Pearson Education	2 nd Edition, 2016
2	CMOS Digital Integrated Circuits, Analysis and Design	Sung-Mo Kang, Yusuf Leblebici, Chulwoo Kim	Tata McGraw Hill	4 th Edition, 2019

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	CMOS: Circuit Design, Layout, and Simulation	R Jacob Baker	Wiley	4 th Edition, 2019
2	CMOS VLSI Design: A Circuits and Systems Perspective	Neil Weste, David Harris	Pearson Education	3 rd Edition, 2010
3	Basic VLSI Design	Douglas A. Pucknell, Kamran Eshragian	PHI	3 rd Edition, 1995
4	CMOS Logic Circuit Design	John P Uyemura	Springer	2005

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/108107129
2	https://nptel.ac.in/courses/117106092 https://nptel.ac.in/courses/108107129
3	https://nptel.ac.in/courses/117106092 https://nptel.ac.in/courses/108107129
4	https://onlinecourses.nptel.ac.in/noc23_ee137/preview

SEMESTER S5

ROBOTICS AND AUTOMATION

Course Code	PEAET595	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)	PCAET303 Transducers and Measurements	Course Type	Theory

Course Objectives:

1. To introduce the fundamental concepts and terminology in Robotics and automation
2. To familiarize the various industrial applications of robotics

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of Robotics Robotics and Automation – Definition and history of robotics, Differences between robotics and automation, Applications of robotics in industry and service sectors. Robot Anatomy – Basic components - Links, joints, and end effectors, Degrees of Freedom (DOF) and their significance. Configurations of Robots – Cartesian, Cylindrical, Spherical, Articulated, SCARA. Work Volume and Workspace Analysis – Definition and importance, Factors affecting workspace. Manipulator Kinematics – Position representation, Introduction to forward and inverse kinematics, Homogeneous transformations and their application in robot kinematics. D-H Notations – Formulating and solving kinematic equations.	9
2	Control Systems for Robots Basic Control System Models – Open-loop and closed-loop control, Block diagrams and transfer functions. Robot Motions – Types of motions – Slew motion, joint-interpolated	9

	motion, and straight-line motion. Path planning and trajectory generation. Controllers – On/off control, Proportional (P) control, Integral (I) control, Proportional plus integral (PI) control, Proportional plus derivative (PD) control and Proportional plus integral plus derivative (PID) control.	
3	Actuation and Feedback Mechanisms Sensors – Types of sensors - Position and velocity sensors. Working principles of encoders and resolvers, Potentiometers and tachometers. Actuators - Electric actuators - DC motors, stepper motors, and servomotors. Hydraulic actuators, Pneumatic actuators. Power Transmission Devices - Gears, belts, chains, lead screws and ball screws. End Effectors – Types of grippers - Mechanical, vacuum and magnetic, Design considerations for grippers. Methods of Power and Control Signal Transmission - Electrical, hydraulic and pneumatic transmission.	9
4	Industrial Applications and Work Cell Design Material Handling - General considerations for material handling with robots, Material transfer applications. Pick and Place Operations - Techniques and applications, Integration with production lines. Palletizing and Related Operations - Methods and case studies. Manufacturing Processes - Die casting, plastic molding, forging, Machining operations, stamping press operations, Role of robots in automation of these processes. Robot Cell Layouts - Design considerations for multiple robots and machine interfaces, Examples of typical robot cell layouts. Work Cell Control - Interlocks and safety mechanisms, Error detection and recovery strategies. Work Cell Controllers - Types and functions of work cell controllers, Integration with other control systems. Cycle Time Analysis - Techniques for analyzing and optimizing robot cycle times, Factors affecting cycle time and productivity.	9

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

Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Internal Ex</i>	<i>Evaluate</i>	<i>Analyse</i>	<i>Total</i>
5	15	10	10	40

Criteria for Evaluation (Evaluate and Analyse): 20 marks

- Each student should Design, simulate, and analyze a robotic arm with three or more degrees of freedom (DoF) for a pick and place system, operating within a defined work volume.
- Computational tools such as MATLAB or Octave can be utilized for simulation and analysis.
- Find below the details of the project and the outcomes to be evaluated.

Project: Design, simulate, and analyze a robotic arm with three or more degrees of freedom (DoF) for a pick and place system, operating within a defined work volume.

Project Components:**1. Design Specifications and Simulation**

- Develop comprehensive arm specifications, including: a) Link dimensions b) Joint movement parameters c) Actuator specifications d) Sensor requirements
- Ensure design enables full access to the specified work volume
- Create a detailed 3D model for simulation purposes

2. Kinematic Analysis

- Derive kinematic equations using Denavit-Hartenberg (DH) parameters
- Construct homogeneous transformation matrices
- Implement and validate forward as well as inverse kinematics

3. Path Planning and Motion Simulation

- Define an efficient path for pick and place operations
- Simulate arm movements along the planned path
- Analyze motion profiles for optimization opportunities

4. Actuator Modeling and Dynamic Analysis

- Develop an electric motor models for joint actuation
- Simulate joint torques and forces during movement under a fixed load condition

5. Control System Implementation and Evaluation

- Implement multiple control strategies: a) ON-OFF control b) Proportional (P) control c) Proportional-Integral (PI) control d) Proportional-Integral-Derivative (PID) control
- Simulate arm movement along the predefined path under load for each control strategy
- Evaluate and compare performance metrics for each control method

Project Deliverables:

1. Detailed design specifications and 3D model
2. Kinematic and dynamic analysis reports
3. Identify and address technical challenges encountered
4. Simulation results and performance comparisons
5. Comprehensive project report including methodology, results, challenges, and recommendations

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)	• 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	Describe the basic components, structural configurations and degrees of freedom (DOF) of robots.	K2
CO2	Apply forward and inverse kinematics for different types of robotic manipulators.	K3
CO3	Implement various types of controllers and understand their impact on robot motion control	K3
CO4	Identify and compare different types of sensors and actuators used in robotic systems	K2
CO5	Understand the basics of robot cell layouts considering multiple robots and machine interfaces.	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										3
CO2	3	3		2								3
CO3	3	2	3	2	2							3
CO4	3	3	3	2	3							3
CO5	3	2	3	2	2	2	2			2	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 Robotics: Mechanics and Control	John J. Craig	Pearson	4 th Edition, 2022
2	Robot Modeling and Control	Mark W. Spong, Seth Hutchinson, and M. Vidyasagar	Wiley	2 nd Edition, 2020
3	Industrial Robotics - Technology, Programming and Applications	Mikell P Groover, Mitchell Weiss, Roger N Nagel, Nicholas Odrey, Ashish Dutta	Mc Graw Hill	2 nd Edition, 2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Modern Robotics: Mechanics, Planning, and Control	Kevin M. Lynch, Frank C. Park	Cambridge University Press	1 st Edition, 2017
2	Robotics: Modelling, Planning and Control	Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo	Springer	1st Edition, 2009
3	Robotics, Vision and Control: Fundamental Algorithms In MATLAB	Peter Corke	Springer	2 nd Edition, 2017

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/107106090
2	https://nptel.ac.in/courses/107106090
3	https://nptel.ac.in/courses/107106090
4	https://nptel.ac.in/courses/107106090

SEMESTER S5
PROCESS CONTROL LAB

Course Code	PCAEL507	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)	PCAEL307: Transducers and Measurements Lab., PCAET502: Process Dynamics and Control	Course Type	Lab

Course Objectives:

1. To study the responses of various controllers and valves
2. To simulate various types of controller using SIMULINK/MATLAB/Labview
3. To provide experience on control of various industrial processes using different control paradigms

Expt. No.	Experiments
PART A (Minimum 8 experiments are mandatory)	
1	Study of responses of P, PD, PI and PID controllers on Level/ Flow/ Thermal/ Pressure processes
2	Study of responses of ON-OFF controller and ON-OFF controller with dead zone.
3	Controller tuning using continuous cycling method
4	Controller tuning using Process Reaction curve method
5	Characteristics of Linear, Equal percentage and Quick opening valves
6	Control of Stepper motor/Water level/Bottle filling plant using PLC
7	Experiment to determine non-linearity if any, in a plant.
8	Data acquisition with ADC/DAC card and control applications using LabVIEW (Speed control / Temperature control)
9	Design and testing of a RTD based Temperature transmitter on a prototyping board.

10	Design and testing of an analog PID controller on a prototyping board.
	Part B (Minimum 2 experiments are mandatory)
	Experiments (1-4) shall be done using Arduino/Python/LabVIEW/MATLAB/SIMULINK
1.	PC based control of robotic arm
2.	Simulation study of feed-forward, cascade, and ratio control systems using MATLAB/SIMULINK
3.	PID controller design using MATLAB/SIMULINK
4.	Simulation of PID controller using MATLAB/SIMULINK/LabVIEW

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	Make use of basic transducers for the measurement of physical variables like pressure, temperature etc.	K4
CO2	Familiarize various simulation tools -MATLAB, Labview, SIMULINK	K3
CO3	Tune controllers using Ziegler- Nichols & Cohen- Coon techniques	K4
CO4	Implement sensor-based measurement systems using modern tools	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	3	2					3			3
CO2	3	2	3	2	3				3			3
CO3	3	2	3	3					3			3
CO4	3	2	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	Process Control: Modeling, Design and Simulation	B.Wayne Bequette	PHI	1 st edition, 2002
2	Process Instrumentation and control Handbook	Considine	McGraw Hill	5 th edition., 2009

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 S5

LINEAR INTEGRATED CIRCUITS AND SIMULATION LAB

Course Code	PCAEL508	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)	PCECT403: Linear Integrated Circuits	Course Type	Lab

Course Objectives:

1. To study the design and implementation of various linear integrated circuits.
2. To familiarize the simulation of basic linear integrated circuits.

Expt. No.	Part A – List of Experiments using Op Amps (Minimum seven experiments mandatory)
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

	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 section I
2	Simulation of experiments 3 or 4 from section II

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 linear integrated circuits using Op Amps.	K4
CO2	Design and implement basic linear integrated circuits using linear ICs.	K4
CO3	Design and simulate the functioning of basic linear integrated circuits and linear ICs using simulation tools.	K4
CO4	Effectively troubleshoot a given circuit and 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	2						3			3
CO2	3	3	2						3			3
CO3	3	3	2		3				3			3
CO4	3	3	2						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	Linear Integrated Circuits	D. Roy Choudhary and Shail B Jain	New Age International	6 th edition, 2021
2	Introduction to Pspice Using Orcad for Circuits and Electronics	M. H. Rashid	Pearson	3 rd edition, 2015

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 6

APPLIED ELECTRONICS AND INSTRUMENTATION

SEMESTER S6

ELECTRIC DRIVES AND CONTROL

Course Code	PCAET601	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)	GXEST104 Introduction to Electrical and Electronics Engineering	Course Type	Theory

Course Objectives:

1. To study and analyze various electrical drives and its control.
2. To design and analyze various power converter circuits for various applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	DC and AC Machines DC machines – Principle of operation of DC generator, constructional details, EMF equation, types of generators. Principle of operation of DC motors. Electrical and mechanical characteristics of DC series, shunt and compound motors, applications. AC machines – Principle of operation, rotating magnetic field, single phase and three phase induction motors.	11
2	Power Devices and Controlled Rectifiers Power devices – Power BJT, power MOSFET and IGBT - steady state and switching characteristics. Drive requirements. Design of simple drive circuits for power BJT, power MOSFET and IGBT. Principle of DC motor control. Principle of PWM switching control. Two quadrant and four quadrant converter circuit. Controlled rectifiers – Principle of phase controlled converter operation. Single phase half wave and full wave controlled rectifiers with R, RL and battery loads.	12

3	Inverters Single phase inverters - half bridge, full bridge and push pull inverter, Three phase voltage source inverter. Fundamental concepts of PWM schemes, Sine triangle PWM, Space vector PWM, harmonic distortion factors for three phase inverters.	10
4	Induction Motor Drives and Vector Control Techniques Induction motor drives – Torque-speed characteristics of induction motor, Speed control by varying stator frequency and voltage. Voltage source inverter driven induction motor, application of PWM for induction motor drive. Vector Control Techniques – Concepts of Direct Torque Control (DTC), Field Oriented Control (FOC), Comparison of vector control and scalar control. Application of Vector control drives.	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	Illustrate the concept of DC Machines and AC Machines	K3
CO2	Analyze the behavior of Power devices and Controlled Rectifier circuits	K4
CO3	Design and analyze Inverter circuits	K4
CO4	Understand and analyze induction motor drives and vector control techniques	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	3	2									3
CO2	3	3	2									3
CO3	3	3	2									3
CO4	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	Theory and performance of Electrical Machines	J B Gupta	SK Kataria and Sons	15 th Edition, 2015
2	Power Electronics: Essentials and Applications	L. Umanand	Wiley India Pvt. Ltd.	1 st Edition, 2009
3	Power Electronics: Converters Application and Design	Ned Mohan, Tore M . Undeland, William P. Robbins	John Wiley and Sons	3 rd Edition, 2002

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	A Textbook of Electrical Technology. AC and DC Machines (Volume II)	B.L Theraja and A.K Theraja	S Chand and Company Ltd	Multicolor Edition, 2020 Reprint
2	Electric Motor Drives, Modeling Analysis and Control	R. Krishnan	PHI	1 st Edition, 2001
3	Power Electronics: Circuits, Devices and Applications	Mohammad H Rashid	Pearson	4 th Edition, 2017

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/108/104/108104140/ https://nptel.ac.in/courses/108108077
2	https://archive.nptel.ac.in/courses/108/104/108104140/ https://nptel.ac.in/courses/108108077
3	https://archive.nptel.ac.in/courses/108/104/108104140/ https://nptel.ac.in/courses/108108077
4	https://archive.nptel.ac.in/courses/108/104/108104140/ https://nptel.ac.in/courses/108108077

SEMESTER S6

INDUSTRIAL INSTRUMENTATION

Course Code	PCAET602	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 understand the working of different types of temperature, pressure, displacement, level and flow sensors

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Temperature Measurement Resistance Thermometers – Linear approximation and quadratic approximation, principle of operation. Thermistors – Construction, characteristics, applications, Resistance Temperature detectors. Thermocouples – Laws, types, comparisons with other temperature sensors. Thermopiles, Different types of pyrometers, Infrared guns, electronic temperature switches, fluidic sensors, Johnson noise thermometer, Humidity and moisture measurement.	9
2	Pressure and displacement Measurement Mechanical devices – Bellows, Bourdon tube, diaphragm, types of variable inductance and capacitance, strain gauge and its types, piezo electric type, potentiometric type, mano meters. Low pressure and vacuum measurements – Pirani gauge, McLeod gauge, ionization gauge. Differential Pressure Transmitters – Pneumatic transmitter. Displacement measurements – LVDT, RVDT, Proximity sensors, Hall effect devices.	9

3	Flow and Viscosity Measurement Differential pressure flow meters – Laminar and turbulent flow, Bernoulli's theorem, Orifice plate, Venturi Tubes and Nozzles, Pitot Tubes. Positive Displacement Flowmeters – Reciprocating piston meters, Oval gear meters, Nutating disc flow meter. Mass Flowmeters – Radiation type, Angular Momentum type, Impeller Turbine Flow meter, Constant torque type. Electromagnetic and ultrasonic flow meter. Measurement of Viscosity – Principle, Newtonian fluids, Viscometer types – Saybolt and Red wood. Capillary Viscometers – Differential Pressure type.	9
4	Level and Turbidity Measurement Level Measurement Methods – Dip stick, Sight glass, Float Type level indicator, Ball float, hydrostatic pressure level sensor. Displacer Type – Torque tube assembly. Electrical Methods – Resistance, Conductance, Inductive and Capacitive level gauging. Ultrasonic Method, Microwave Level Switches, Non-contacting optical level sensor, Rotating Paddle Switches, laser sensor. Turbidity Measurement – Electronic turbidity meters.	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 working of different types of temperature sensors	K2
CO2	Illustrate the various types of pressure and displacement measurement techniques	K2
CO3	Analyze the working of various flow and viscosity measurement devices	K4
CO4	Illustrate the different types of level and turbidity sensors	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						2				3
CO2	3	3						2				3
CO3	3	3						2				3
CO4	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	A course in Electrical and Electronic Measurements and Instrumentation	A K. Sawhney	Dhanpat Rai & Co. Limited	2/e, 2015
2	Principles of Industrial Instrumentation	D Patranabis	Tata McGraw Hill	3/e, 2017
3	Industrial Instrumentation & Control	S. K. Singh,	Tata McGraw Hill	3/e, 2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Applied Instrumentation in the Process Industries – A survey	Andrew W.G,	Gulf Publishing Company	2001
2	Process / Industrial Instruments & Controls Handbook	Douglas M. Considine	McGraw Hill	5/e, 2009
3	Flow measurement, 2nd Edition 1995.	Spitzer D. W.,	Butterworth Heinemann	2 nd Edition, 1995
4	Instrumentation Reference Book	Noltingk B.E.	Butterworth Heinemann	2/e, 2013

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/108105064
2	https://nptel.ac.in/courses/108105064
3	https://nptel.ac.in/courses/108105064
4	https://archive.nptel.ac.in/courses/103/105/103105130/

SEMESTER S6

CMOS CIRCUIT DESIGN

Course Code	PEAET631	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)	PCAET302: Electronic Devices and Circuits	Course Type	Theory

Course Objective:

1. This course aims to impart the basic knowledge of CMOS analog circuits design and enable the students to design integrated circuits.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic MOS Device physics - Review of MOS Characteristics and Second order effects (only basic theoretical concepts). Single Stage Amplifiers. Common Source Stage with Different Load types , Source Follower, Common Gate and Cascode Stage	9
2	Differential Amplifiers - Single-ended and differential operation, Basic differential pair, Common-mode response, Differential pair with MOS load, Gilbert Cell. Current Mirror: Simple, Cascode and Basic concepts of active current Mirror.	9
3	Frequency Response of Amplifiers: Miller Effect, Poles and Zeros, Frequency Response Analysis of Common Source, Source Follower, Common Gate and Differential Pair.	9
4	Phase Locked Loops - Mathematical model of VCO, Phase Detector, Basic PLL Topology, Type I and Type II (Charge Pump) PLL, Stability Analysis of PLL, Non Ideal Effects in PLL, Application of PLL - Frequency Multiplication, Frequency synthesizer and Skew reduction. Block Diagram of Digital PLL.	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	Analyze various Single stage Amplifiers with different types of loads	K3
CO2	Design and Analyse Differential Amplifiers	K3
CO3	Design various types of current mirrors	K3
CO4	Analyze the frequency response of single stage and differential amplifiers	K3
CO5	Implement PLL for various applications	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	2	2							3
CO3	3	2	2	2	2							3
CO4	3	2	2	2	2							3
CO5	3	2	2	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	Design of Analog CMOS Integrated Circuits	Behzad Razavi	McGraw-Hill	2/e, 2017
2	CMOS Digital Integrated Circuits, Analysis and Design	Sung-Mo Kang, Yusuf Leblebici, Chulwoo Kim	McGraw-Hill	Revised 4/e, 2019

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	CMOS Analog Circuit Design	Phillip E. Allen, Douglas R. Holbery	Oxford	2004
2	CMOS: Circuits Design, Layout and Simulation	R. Jacob Baker	Wiley	2 nd edition, 2009
3	CMOS: Circuit Design, Layout and Simulation (IEEE Press Series on Microelectronic Systems)	R. Jacob Baker	Wiley-IEEE Press	4 th edition, 2019

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/117/101/117101105/ https://archive.nptel.ac.in/courses/108/107/108107129/
2	https://archive.nptel.ac.in/courses/117/101/117101105/ https://archive.nptel.ac.in/courses/108/107/108107129/
3	https://archive.nptel.ac.in/courses/117/101/117101105/ https://archive.nptel.ac.in/courses/108/107/108107129/
4	https://archive.nptel.ac.in/courses/117/101/117101105/ https://archive.nptel.ac.in/courses/108/107/108107129/

SEMESTER S6
INSTRUMENTATION FOR AGRICULTURE

Course Code	PEAET632	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 explain and apply fundamental principles of agricultural instrumentation to monitor key parameters
2. Describe the function and importance of different soil sensors and demonstrate their use in real-world agricultural scenarios.
3. To analyze and classify different soil types (sandy, clay, silt, loamy) based on their characteristics and evaluate their suitability for various agricultural practices.
4. Able to evaluate and optimize various agricultural practices, such as irrigation methods and greenhouse climate control, using data collected from sensors and environmental monitoring systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Agricultural Instrumentation and Soil Types Fundamentals of Agricultural Instrumentation, Importance of instrumentation and control in agriculture. Overview of precision agriculture and smart farming. Agricultural parameters to be monitored - soil moisture, temperature, humidity, pH, nutrient levels, light intensity, and CO₂ levels. Classification and characteristics of different soil types - sandy, clay, silt. Loamy soil. Soil Monitoring Systems - Soil Sensors - Soil moisture sensor, capacitive sensors. Soil temperature sensors - thermocouples, RTDs, thermistors. Gypsum block soil moisture sensors. Soil pH sensors - ion-selective electrodes.	9

2	Water Quality Parameters - pH, electrical conductivity, dissolved oxygen, turbidity. Basic principles of water quality sensors. Irrigation Systems - Necessity and methods - overhead, center pivot, lateral move, micro irrigation systems, irrigation scheduling, and irrigation efficiencies (basic concepts only).	9
3	Greenhouse Monitoring and Climate Control. Basics of Greenhouses - Introduction to greenhouse structures and their importance. Environmental control in greenhouses - temperature, humidity, light, and CO₂ management. Environmental Sensors – hair hygrometer, dry and wet bulb hygrometer. Light sensors - photodiodes, pyranometers. CO₂ sensors - NDIR sensors. Microclimate Monitoring, Importance of microclimate in greenhouse and field agriculture.	9
4	Plant growth monitoring - Leaf area, length, evapotranspiration, wetness & respiration measurement, electromagnetic radiations photosynthesis, infrared & UV bio sensor methods in agriculture. Weather Stations - Components and functionality - Anemometers, sonic anemometers, surface flux measurement. Ground water occurrence - confined and unconfined aquifers Introduction to vertical farming and hydroponics.	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 necessity and fundamentals of instrumentation in agriculture	K2
CO2	Illustrate learn about different soil and water parameters and their properties	K2
CO3	Familiarize various sensors and their applications in monitoring agricultural parameters	K2
CO4	Design and implement effective soil and environmental monitoring 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	2	2		3	3	3					3
CO2	3	2	2		3	3	3					3
CO3	3	2	2		3	3	3					3
CO4	3	2	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	Process Control and Instrumentation Technology	Curtis D. Johnson	Pearson Education India	8 th edition 2015
2	Industrial Instrument and Control	S K Singh	McGraw Hill Education	3 rd Edition 2017
3	Textbook of Soil Science	T. Biswas, S Mukherjee	McGraw Hill Education	2 nd edition 2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Textbook on Fundamentals of Soil Science	M. Yuvaraj	Brillion Publishing	2023
2	Agricultural Automation: Fundamentals and Practices	Francis J. Pierce, Qin Zhang	CRC Press	2013
3	Process Control: Instrument Engineers' Handbook	Béla G. Lipták	Butterworth-Heinemann	2013

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/126/105/126105016/
2	https://archive.nptel.ac.in/courses/126/105/126105019/
3	https://www.youtube.com/watch?v=xT1Nlyo_CxI
4	https://onlinecourses.nptel.ac.in/noc24_ag10/preview

SEMESTER S6

DISCRETE CONTROL SYSTEMS

Course Code	PEAET633	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)	PCAET501: Control System Theory	Course Type	Theory

Course Objectives:

1. To understand the signal conversion and processing involved in discrete data control systems
2. To carry out stability analysis of discrete time control systems
3. To acquire knowledge in state space representation of systems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to DCS Basic Elements of discrete data control systems, advantages of discrete data control systems, examples. Signal conversion & processing: Digital signals & coding, data conversion & quantization, sample and hold devices. Mathematical modelling of the sampling process, Design of maximum sampling frequency of digital systems in terms of the sensor delay; Data reconstruction and filtering of sampled signals: Zero Order hold & First order Hold.	9
2	Discrete Time Control Systems Pulse transfer function, Z transform analysis of closed loop and open loop systems- Steady state error analysis of digital systems- Examples on static error coefficients. Bilinear transformation- mapping from s-plane to z-plane	9
3	Analysis of Discrete Time Control Systems Stability analysis of linear digital control systems - Routh Hurwitz criteria, Jury's test. Root loci of digital control systems - rules for construction of root	9

	locus. Frequency domain analysis - Bode plots- Gain margin and Phase margin.	
4	State Space Analysis State space representation of discrete time systems- State space model- various canonical forms from transfer function, Conversion of transfer function model to state space model, Discrete time State transition matrix, Solution of discrete state equations, Controllability and Observability, Pole placement using state feedback.	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 basic elements, their functions and Interconnections in a digital control system.	K2
CO2	Develop the pulse transfer function and steady state error analysis of digital control systems	K3
CO3	Understand frequency domain analysis and analyse stability of linear digital control systems.	K3
CO4	Develop state space representation of discrete time systems and find solution of state equation.	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	2								2
CO2	3	3	3	2								2
CO3	2	3	3	3	3							2
CO4	3	3	3	3								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	Discrete- Time Control Systems	Katsuhiko Ogata	Prentice Hall of India, 2005	2 nd Edition, 2005
2	Digital control systems	B. C. Kuo	Oxford University Press	2 nd Edition, 2007
3	Digital Control and State variable methods	M. Gopal	Tata McGraw Hill	4 th Edition, 2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Continuous & Discrete Control Systems	John Dorsey	Tata McGraw Hill	2001
2	Modern Control Systems	Richard C Dorf and Robert H. Bishop	Pearson Education	2001

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/108103008
2	https://nptel.ac.in/courses/108103008
3	https://nptel.ac.in/courses/108103008
4	https://nptel.ac.in/courses/108103008

SEMESTER S6

AUTOMOTIVE ELECTRONICS

Course Code	PEAET634	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)	PCAET501 Control System Theory	Course Type	Theory

Course Objectives:

1. To illustrate Electronic Engine control system and cruise control systems.
2. To analyse various automotive electronic systems, hybrid drives and power management systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basics of Electronic Engine Control Overview of electronics in vehicles, Need for Electronic Engine Control, Concept of an Electronic Engine Control System, Inputs and outputs to engine control system, Electronic Fuel Control System, Closed Loop Electronic Fuel Control System and Electronic Ignition System	8
2	Vehicle Motion Controls Representative Cruise Control System – Digital Cruise Control Configuration and block diagram, cruise control speed performance. Digital speed control. Cruise Control Electronics - Basic concepts of Stepper Motor based and Vacuum Operated Actuator. Basics of Antilock Braking System, Electronic Suspension Control System and Electronic Steering Control.	10
3	Power Systems and Hybrid Drives Battery management system – Battery types and its maintenance, Capacity Rating, Battery charging methods, Battery tests. Modern battery types -	10

	Lithium-ion battery, Fuel cells, Ultra capacitors. Charging System – Basic charging system principle, Alternator in vehicles, rectification of AC to DC, Example of charging circuit, smart charging. Engine Starting system – Introduction, starting requirements, block diagram of starting system, electronic starter control Concept of Electric vehicles, Hybrid Drive concept, Types of hybrid – series, parallel, micro, mild and strong hybrid. Concept of Recuperative brake system.	
4	Automotive Instrumentation and Diagnostics Modern Automotive Instrumentation – General and computer based instrumentation system, Advantages of Computer-Based Instrumentation. Fuel Level Measurement and Indication, Vehicle Speed Measurement, High-Speed Digital Communications - CAN Protocol (Basics concepts only), Trip Information Computer, Airbag deployment. Electronic Control System Diagnostics, Service Bay Diagnostic Tool, On-board Diagnosis (OBD II)	8

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 =24 marks)	- 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	Demonstrate the working of electronic engine control systems	K2
CO2	Illustrate the cruise control systems	K2
CO3	Design the power systems and hybrid drive for vehicles.	K3
CO4	Understand the automotive instrumentation systems and vehicle diagnostics	K2

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
CO2	3	2	3									3
CO3	3	2	3									3
CO4	3	2	3									3

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Understanding Automotive Electronics: An Engineering Perspective	William B. Ribbens	Butterworth-Heinemann Inc	8th Edition, 2017
2	Bosch Automotive Electrics and Automotive Electronics: Systems and Components, Networking and Hybrid Drive	Bosch	Springer	5th Edition, 2013
3	Automobile Electrical and Electronic Systems	Tom Denton	Elsevier	3 rd Edition, 2004

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automotive Electronics Design Fundamentals	Najamuz Zaman	Springer	1st Edition, 2015
2	Automotive Electrical and Electronics	A K Babu	Khanna Book Publishing	2nd Edition, 2017
3	Hillier's Fundamentals of Motor Vehicle Technology	V.A.W Hillier	Oxford	6th Edition, 2012
4	Automotive Electrical Equipment	P L Kohli	McGraw Hill	1st Edition, 2017
5	Automotive Electricity and Electronics	Barry Hollembeak	Cengage Learning	7 th Edition, 2018

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/107/106/107106088/
2	https://archive.nptel.ac.in/courses/107/106/107106088/
3	https://archive.nptel.ac.in/courses/107/106/107106088/
4	https://archive.nptel.ac.in/courses/107/106/107106088/

SEMESTER S6

BIOMEDICAL IMAGING

Course Code	PEAET636	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)	PCECT402 Signals and Systems	Course Type	Theory

Course Objectives:

1. To introduce the fundamental concepts of biomedical imaging and its analysis.
2. To understand various medical imaging modalities and their applications.
3. To learn techniques for image enhancement, segmentation, and analysis.
4. To apply image analysis techniques to real-world biomedical problems.
5. To gain practical experience through laboratory exercises and projects.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Biomedical Imaging - Introduction to Biomedical Image Analysis, Medical Imaging Modalities- X-ray, CT, MRI, Ultrasound, PET and Microscopy. Image Acquisition and Reconstruction, Image Storage, Retrieval, and Communication - Applications of Biomedical Imaging	9
2	Image Pre-processing and Enhancement Image Pre-processing- Noise Reduction, Smoothing, and Filtering - Image Enhancement Techniques - Histogram Equalization, Contrast Stretching, Homomorphic Filtering, and Multiresolution Analysis - Edge Detection Techniques: Sobel, Canny, and Laplacian - Image Restoration and De-noising Techniques.	9
3	Image Segmentation and Feature Extraction Image Segmentation Techniques - Thresholding, Region Growing, and Clustering - Advanced Segmentation Methods: Watershed, Level Set, and Graph Cut - Feature Extraction: Shape, Texture, and Intensity-based features - Feature Selection and Dimensionality Reduction Techniques.	9

4	Image Analysis and Applications Image Classification Techniques - Supervised and Unsupervised Learning - Pattern Recognition and Machine Learning in Biomedical Image Analysis - Case Studies: Tumor Detection, Organ Segmentation, and Disease Diagnosis - Evaluation Metrics for Image Analysis: Sensitivity, Specificity, and ROC Curves - Current Trends and Future Directions in Biomedical Image Analysis	9
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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 principles of various biomedical imaging modalities	K2
CO2	Apply image pre-processing and enhancement techniques	K3
CO3	Perform image segmentation and feature extraction for biomedical applications	K4
CO4	Analyze biomedical images using classification and pattern recognition techniques	K4
CO5	Evaluate the performance of image analysis methods in real-world biomedical problems	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	2	2									3
CO2	3	3	3	2								3
CO3	3	3	3	2	2							3
CO4	3	3	3	3	2							3
CO5	3	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	Biomedical Image Analysis	Rangaraj M. Rangayyan	CRC Press	2004
2	Digital Image Processing	Rafael C. Gonzalez, Richard E. Woods	Pearson Education	4th Edition, 2018
3	Medical Image Processing, Reconstruction and Restoration	Jiri Jan	CRC Press	2005
4	Medical Imaging Signals and Systems	Jerry L. Prince, Jonathan Links	Pearson Education	2006

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Image Processing, Analysis, and Machine Vision	Milan Sonka, Vaclav Hlavac, Roger Boyle	Cengage Learning	4th Edition, 2014
2	Pattern Recognition and Machine Learning	Christopher Bishop	Springer	2006
3	Medical Image Analysis	Atam P. Dhawan	Wiley-Interscience	2003
4	Handbook of Medical Imaging	Jacob Beutel, Harold L. Kundel, Richard L. Van Metter	SPIE Press	2000

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	Introduction to Biomedical Imaging: NPTEL Lecture Series by Prof. Arun Kumar Thittai
2	Image Processing Techniques: NPTEL Course on Digital Image Processing by Prof. P. K. Biswas
3	Advanced Image Segmentation: NPTEL Course on Medical Image Analysis by Ganapathy Krishnamurthi
4	Machine Learning in Medical Imaging: NPTEL Course on Deep Learning for Computer Vision by Prof. Vineeth N Balasubramanian

SEMESTER S6

DIGITAL IMAGE PROCESSING

Course Code	PEAET635	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)	PBECT504 Digital Signal Processing	Course Type	Theory

Course Objectives:

1. To establish a theoretical foundation for fundamental concepts in Digital Image Processing
2. Comprehend the algorithms utilized in two-dimensional signal processing.
3. Apply image processing techniques to address engineering challenges.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Digital Image Fundamentals - Image representation, basic relationship between pixels, elements of DIP system, elements of visual perception-simple image formation model. Digital Camera working principles Brightness, Contrast, Hue, Saturation. Colour image fundamentals - RGB, CMY, HIS models, 2D sampling, Quantization. Review of matrix theory - Row and column ordering - Toeplitz, Circulant and block matrix.	9
2	2D Image transforms - DFT and its properties, DCT, KL transform and Singular Value Decomposition. Image Enhancement - Spatial domain methods - point processing- intensity transformations, histogram processing, image subtraction, image averaging. Spatial filtering- smoothing filters, sharpening filters. Frequency domain methods - low pass filtering and high pass filtering.	9
3	Image Restoration - Degradation model, Unconstrained restoration- Lagrange multiplier and constraint restoration	9

	Inverse filtering - removal of blur caused by uniform linear motion. Feature Extraction - Introduction to feature extraction techniques-Harris corner detection, SIFT	
4	Feature descriptors - Histogram of Oriented Gradients (HOG), Scale Invariant Features Image Classification - Support Vector Machine, Decision Trees, Object Detection using HOG, Object Detection using Viola-Jones Algorithm. Image Segmentation - Thresholding, Region-based segmentation, Clustering techniques (k-means). Morphological Operations - Dilation and Erosion, Opening and Closing, Hit-or-Miss transformation, Boundary Extraction, Region filling,	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

- Each student should design, implement, and analyze a digital image processing system for various applications.
- System development can be accomplished using
 - Python: OpenCV, NumPy, Scikit-image
 - MATLAB: Image Processing Toolbox
- **Each student should do minimum two microprojects from each of the below Topics 1 to 5. Topic 6 is not compulsory.**

• **Topic 1: Basic Image Manipulation**

- Grayscale Conversion: Convert color images to grayscale.
- Image Resizing: Implement different resizing techniques (nearest neighbor, bilinear, bicubic).
- Image Cropping: Allow users to crop specific regions of an image.
- Image Rotation: Rotate images by specified angles.
- Image Flipping: Flip images horizontally or vertically.

- **Topic 2: Image Enhancement**
 - Contrast Adjustment: Adjust image contrast using linear or non-linear methods.
 - Brightness Adjustment: Modify image brightness.
 - Histogram Equalization: Enhance image contrast using histogram equalization.
 - Image Sharpening: Apply sharpening filters to enhance image details.
- **Topic 3: Image Filtering**
 - Averaging Filter: Apply a smoothing filter to reduce noise.
 - Median Filter: Remove noise while preserving edges.
 - Gaussian Blur: Create a Gaussian blur effect.
 - Edge Detection: Implement edge detection techniques (Sobel, Canny).
- **Topic 4: Image Analysis**
 - Image Segmentation: Divide an image into meaningful regions.
 - Object Detection: Detect specific objects within an image.
 - Feature Extraction: Extract relevant features from images
- **Topic 5: Image Classification**
 - Traffic Sign Recognition: Classify common traffic signs (stop, yield, speed limit, etc.).
 - Cat vs. Dog Classification: Build a model to differentiate between cat and dog images.
 - Classify fruits (apples, oranges, bananas).
- **Topic 6 (optional): Advanced Image Classification with Machine Learning**
 - Recognize different types of flowers.
 - Classify types of cars (sedan, SUV, truck).
 - Detect objects in images (faces, cars, pedestrians).

The project deliverables consist of the following components:

- Detailed design specifications
- Identification and resolution of technical challenges
- Designed and developed algorithms
- Implementation results and performance evaluations
- Comprehensive project report, incorporating methodology, results, challenges, and recommendations.

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)	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	Identify and summarize the aspects of digital image processing.	K2
CO2	Demonstrate knowledge of the significance of transforms in digital image processing.	K2
CO3	Apply principles and techniques of image restoration, enhancement, and segmentation.	K2
CO4	Utilize modern principles and techniques for classifying and segmenting images.	K3
CO5	Model and solve engineering problems by utilizing digital image processing algorithms.	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	2	2	2								3
CO2	3	2	2	2								3
CO3	3	2	2	2	2							3
CO4	3	2	2	2	2							3
CO5	3	2	3	2	2	2	2	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	Digital Image Processing	Gonzalez Rafel C	Pearson Education	1/e, 2009
2	Fundamentals of digital image processing	Jain Anil K	Prentice Hall	1/e, 1989
3	Foundations of Computer Vision	Antonio Torralba	MIT Press	1/e, 2024
4	Computer Vision: Algorithms and Applications	Richard Szeliski,	Springer	2/e, 2010

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Digital image processing	Kenneth R Castleman	Pearson Education	2/e, 2003
2	Digital image processing	Pratt William K	John Wiley	4/e, 2007
3	Hands-On Image Processing with Python	Sandipan Dey	Packt Publishing	1/e, 2024
4	Computer Vision with Python 3	Saurabh Kapur	Packt Publishing	1/e, 2017
5	Programming Computer Vision with Python	Jan Erik Solem	O'Reilly Media	1/e, 2012

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://www.youtube.com/playlist?list=PL1F076D1A98071E24
2	https://www.youtube.com/playlist?list=PL1F076D1A98071E24
3	https://www.youtube.com/playlist?list=PL1F076D1A98071E24
4	https://www.youtube.com/playlist?list=PL1F076D1A98071E24 https://www.youtube.com/playlist?list=PLwdnzlV3ogoVsma5GmBSsgJM6gHv1QoAo

SEMESTER S6

EMBEDDED SYSTEM DESIGN

Course Code	PEAET695	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)	PBECT404 Microcontrollers	Course Type	Theory

Course Objectives:

1. To introduce the building blocks of Embedded System and various Embedded Development strategies
2. To impart knowledge of RTOS and processor scheduling algorithms

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Embedded Systems Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.	8
2	Typical Embedded System Core of the Embedded System – General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS). Memory – ROM, RAM, Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators, Communication Interface – Onboard and External Communication Interfaces.	10
3	RTOS Based Embedded System Design Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multi processing and Multi-tasking, Task Scheduling, Task Communication – Shared Memory, Message Passing, Device Drivers, How to Choose an RTOS.	9
4	Embedded system development process Requirements, Architecture, Selection of Operating system, Processor Selection, Development platform, Programming language - Coding issues, Code optimization, Efficient input/output-Testing and debugging, Verify the software on the host system, Verify the software on the embedded system	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

- The students should design a complete embedded system which has real life application and is socially relevant.
- Select any ARM Cortex M processor, 16 bit Microcontroller or higher configuration devices.
- The project can be done as design and simulation or complete hardware implementation
- The project needs to be done as an individual project.

At the completion of the project, the students should be familiar with the following:

- Select an appropriate processor/Microcontroller for designing an embedded system
- Design an embedded system with limited resources
- Program the microcontroller/ARM Cortex M processor
- Interface various sensors/actuators/modules to the embedded system
- Parameters to be considered while developing the system for industrial purposes.

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)	• 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	Understand fundamental embedded systems design paradigms, architectures, possibilities and challenges	K2
CO2	Analyze the sub systems of an embedded system and their interaction in the functionality of the embedded systems	K2
CO3	Practically apply gained theoretical knowledge to develop embedded systems.	K3
CO4	Apply formal techniques of simulation, testing, verification and validation in designing reliable and safe embedded 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	2	3		3							3
CO2	3		3		3							3
CO3	3	2	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 Embedded Systems	Shibu K. V	Tata McGraw Hill	2 nd Edition, 2017
2	Embedded System Design – A unified hardware/software Introduction	Frank Vahid, Tony Givargis	John Wiley	2006
3	Embedded Systems- Architecture, Programming and Design	Raj Kamal	Tata McGraw Hill	3 rd Edition, 2017
4	Embedded Systems: An Integrated Approach	Lyla B. Das	Pearson	1 st Edition, 2012

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Embedded System Design	Steve Heath	Elsevier/ Newnes	2 nd Edition, 2002
2	Embedded Microcontrollers and Processor Design	Greg Osborn	Pearson	2011
3	Embedded Microcomputer Systems – Real Time Interfacing	Jonathan W. Valvano	Cengage Learning	2 nd Edition, 2011

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/108102045
2	https://nptel.ac.in/courses/108102045
3	https://nptel.ac.in/courses/108102045 https://archive.nptel.ac.in/courses/106/105/106105172/
4	https://nptel.ac.in/courses/108102045 https://archive.nptel.ac.in/courses/106/105/106105172/

SEMESTER S6

LOGIC AND DISTRIBUTED CONTROL SYSTEM

Course Code	PBAET604	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)	Nil	Course Type	Theory

Course Objectives:

1. To design logic control systems for industrial applications.
2. To design PLC based control systems using ladder programming.
3. To describe distributed control system (DCS) and its components.
4. To explain networking protocols at different levels in hierarchical control

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Programmable Logic Controllers – power supplies and isolators. Program and Data organization in PLC – Input and Output modules, Discrete AC/DC, Analog Input/Output, Modular PLC. PLC programming Methods – IEC 61131-3 standard, Ladder programming. Basic PLC with Load and Store operations, PLC with Conditional Instructions.	9
2	General PLC programming procedures, programming on-off inputs/ outputs, auxiliary commands and functions, PLC basic Functions, register basics, timer functions, counter functions, Arithmetic functions, comparison functions, Skip and MCR functions, data move systems. PLC Advanced intermediate functions - Utilizing digital bits sequencer functions, Basic ladder diagram examples.	9
3	Distributed control system (DCS) - Introduction, DCS configuration with associated accessories, analog control, direct digital control, control console equipment, control unit (Relay Rack mounted equipment), local control	9

	units, attributes of DCS and DCS Flow sheet symbols. DCS System Integration I/O hardware stations, Set-point station control, Engineering interface and operator interfaces in DCS.	
4	Computers in process control - Direct Digital Control (DDC). Centralized control, Hierarchical control, Supervisory Control and Data Acquisition Systems (SCADA). Standard communication protocols for Instrumentation - Introduction, Advantages and limitations of HART Protocol, FIELDBUS and PROFIBUS. Industrial applications of PLC, SCADA, DCS and open systems for following plants - Thermal power plant and Steel Plant.	9

Note: It is mandatory that a *course project* should be done by the students in a group of maximum 4 members. The project can be in any of the following areas.

1. A typical application level wired Logic control system using combinational and/or sequential logic circuit. The entire logic control system (Both the system to be controlled and the designed logic controller) need to be implemented in hardware.
2. A typical application level logic control system with PLC as the controller. The entire logic control system (Both the system to be controlled and the PLC with ladder program) need to be implemented in hardware.

The course project should have interim evaluations and final evaluation which also includes a presentation and demonstration.

Steps involved in PBL:

- Selection of relevant topic.
- Selecting the system (mechanical/electrical/hydraulic/pneumatic) to be controlled.
- Selecting proper sensors.
- Designing the logic controller with digital circuits or using a PLC with Ladder programming.
- Hardware implementation of the logic control system by integrating the system, sensors and the controller developed.

Sample project ideas:

- Bottle filling system control
- Sensor based Traffic light controller
- Robotic arm/manipulator control
- Coffee vending machine

- Renewable power generation management
- Coin counter

Upon successful completion of the project, the student is expected to attain skills to design and make medium complexity logic control systems using combinational and/or sequential logic circuits and also using Programmable Logic Controllers (PLC) with ladder programming.

Evaluation parameters:

- Relevance of the topic
- Hardware Implementation
- Presentation skills

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	Design and implement logic control systems for industrial applications	K6
CO2	Design and implement PLC based control systems using ladder programming	K6
CO3	Describe distributed control system (DCS) and its components	K2
CO4	Explain networking protocols at different levels in hierarchical control	K2

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	3	3		3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	2	2	2								3
CO4	3	2	2	2								3

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Programmable Logic Controllers	W. Bolton	Elsevier	4 th Edition 2006
2	Distributed computer control for Industrial Automation	Popovic and Bhatkar	MareetDekkar, N.York	1990
3	Computer based Industrial Control	Krishna Kant	Prentice Hall, New Delhi	2010
4	Distributed Control Systems	Michael P Lukcas	Van Nostrand Reinhold Co., New York	1986

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Programmable Logic Controllers - Principles and Applications	John.W.Webb, Ronald A Reis	Prentice Hall	5th Edition, 2002
2	Programmable Logic Controllers	Frank D. Petruzella	McGraw Hill, New York	2nd Edition, 2019
3	Elements of Process Control Applications	Deshpande P.B and Ash R.H	ISA Press, New York	1981
4	Computer Aided Process Control	Singh	Prentice Hall	2004
5	Programmable logic devices and logic controllers	Enrique Mandado, Jorge Marcos, Serafin A. Pérez	Prentice Hall	1996
6	Process Control Instrumentation Technology	Curtis D. Johnson	Pearson	8th Edition, 2005

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-me04/
2	https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-me04/
3	https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-me04/
4	https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-me04/

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 S6

DESIGN THINKING AND PRODUCT DEVELOPMENT

(Common to Group A & Group B)

Course Code	GXEST605	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	2:0:0:0	ESE Marks	60
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To guide students through the iterative stages of design thinking, including empathizing with users, defining problems, ideating solutions and developing Proof of Concepts (PoC) and technical feasibility studies.
2. To promote the development of critical thinking skills by engaging students in integrative inquiry, where they ask meaningful questions that connect classroom knowledge with real-world applications.
3. To equip students with the ability to involve in product design considering the sustainability, inclusivity, diversity and equity aspects.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of design thinking and product development: Overview of stages of product development lifecycle; Design thinking -Definition-Design thinking for product innovation; Bringing social impact in ideation- Identifying societal needs-understanding multi-faceted issues-community engagement and empathetic design- technological innovation meeting societal needs; Understanding and Bridging the divide using Human Centered Design (HCD); Designing for inclusivity in product development-embracing user diversity - Long term impact - sustainability encompassing environmental,economic and social dimensions; Technology Readiness Level in the Innovation Life-cycle; Performing a self-check on innovative	6

	ideas - Originality of idea- understanding innovation landscape - patentability - understanding the economic landscape - Unique Selling Proposition (USP) - Repeatability and Manufacturability - Sustainability - Leveraging business models for comprehensive analysis	
2	Empathize: Design thinking phases; Role of empathy in design thinking; Methods of empathize phase - Ask 5 Why/ 5 W+H questions; Empathy maps - Things to be done prior to empathy mapping - Activities during and after the session; Understanding empathy tools - Customer Journey Map - Personas. Define: Methods of Define Phase: Storytelling, Critical items diagrams, Define success.	6
3	Ideation : Stages of ideation; Techniques and tools - Divergent thinking tools - Convergent thinking tools - Idea capturing tools; Cross-industry inspiration; Role of research in ideation - Market research - consumer research - leveraging research for informed ideation; Technological trends - navigating the technological landscape - Integrating emerging technologies; Feasibility studies - technical, economic, market, operational, legal, and ethical feasibility; Ideation session- techniques and tips. Proof of Concept (PoC) : Setting objectives; Risk assessment; Technology scouting; Document and process management; Change management; Knowledge Capture; Validating PoC; Story telling in PoC presentation	6
4	Design: Navigating from PoC to detailed design; Developing Specification Requirement Document (SRD)/Software Requirement Specification (SRS); Design for manufacturability; Industrial standards and readability of code; Design to cost; Pre-compliance; Optimized code; Design Failure Mode and Effects Analysis (DFMEA); Forecasting future design changes. Prototyping: Alpha prototypes; Beta prototypes; Transition from design to prototype; Goals and expectations for Alpha and Beta prototypes; Effective strategies for maintaining timeline in prototyping; Testing and refining Alpha prototypes; Transitioning to Beta prototypes. Pilot build: Definition and purpose of a pilot build; setting objectives; Identification and selection of manufacturing partner for pilot build; Testing procedures in pilot build; Scaling from pilot build to full-scale production / implementation.	6

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

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignments	Internal Examination	Reflective Journal and Portfolio	Total
5	20	10	5	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	Empathize to capture the user needs and define the objectives with due consideration of various aspects including inclusivity, diversity and equity	K5
CO2	Ideate using divergent and convergent thinking to arrive at innovative ideas keeping in mind the sustainability, inclusivity, diversity and equity aspects.	K6
CO3	Engage in Human Centric Design of innovative products meeting the specifications	K5
CO4	Develop Proof of Concepts (PoC), prototypes & pilot build of products and test their performance with respect to the Specification Requirement Document.	K4
CO5	Reflect on professional and personal growth through the learnings in the course, identifying areas for further development	K4

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		2	3	3	3	2	2		3
CO2	3	2	3		2	3	3	3	2	2		3
CO3	3	2	3		2	3	3	2	2	2		3
CO4	3	2	2		3	3	3	2	2	2		3
CO5	3					3	3	2	2	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	Product Sense: Engineering your ideas into reality	Dr. K R Suresh Nair	NotionPress.com	2024
2	Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation	Tim Brown	HarperCollins Publishers Ltd.	2009
3	Design Thinking for Strategic Innovation	Idris Mootee	John Wiley & Sons Inc.	2013

Sample Assignments:

1. Evaluate and prepare a report on how the aspects including inclusivity, diversity and equity are taken into consideration during the empathize and define phases of the Miniproject course.
2. Evaluate and prepare a report on how the aspects including sustainability, inclusivity, diversity and equity are taken into consideration during the ideate phase of the Miniproject course.
3. Evaluate and prepare a report on how User-Centric Design (UCD) is used in the design and development of PoC of the product being developed in the Miniproject course.
4. Prepare a plan for the prototype building of the product being developed in the Miniproject course.
5. Report on the activities during the empathize phase including the maps & other materials created during the sessions.
6. Report on the activities during the define phase including the maps & other materials created during the sessions.
7. Report of all the ideas created during the ideation phase of the Miniproject course through the tools including SCAMPER technique, SWOT analysis, Decision matrix analysis, six thinking hats exercise
8. Prepare a full scale production plan for the product being developed in the Miniproject course.
9. Create a Stanford Business Model Canvas related to the Miniproject.

An industrial visit of at least a day for experiential learning and submit a report on the learnings, for example industry standards and procedures.

SEMESTER S6
TRANSDUCERS AND MEASUREMENTS

Course Code	OEAET611	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)	NIL	Course Type	Theory

Course Objectives:

1. To familiarize the basics of Instrumentation system and its quality parameters.
2. To understand and apply the concepts of various transducers and other measuring instruments.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basics of Measurement- Generalized block diagram of Instrumentation system, Standards, Calibration of meters, Static and Dynamic characteristics of transducers, Errors in measurements and its analysis. Measurement of resistance, capacitance and inductance: DC and AC bridges, Sources and detectors- Balance Equation, Wheatstone Bridge, Maxwell's inductance bridge and Schering bridge	9
2	Transducers - Classification of transducers, Factors influencing choice of transducer. Passive transducers: Principle of operation, Construction details, characteristics, types and applications of Resistance transducers: Potentiometer, Strain gauge, RTD, Thermistor. Inductive Transducer: LVDT. Capacitive transducers: Variable air gap-Variable Area-Variable permittivity.	9
3	Active transducers- Principle of operation, Construction details, Characteristics, types and applications of Thermocouple, Piezo electric transducer, Hall effect transducer, Photovoltaic Cell. Opto-electric Transducers- Photodiode, Phototransistor, LDR Accelerometers: Piezoelectric, potentiometric, LVDT accelerometer.	9

	Non-Contact type transducers- Infrared-Ultrasonic proximity sensors, Optical level sensor-Ultrasonic level sensor, Radiation pyrometer.	
4	Measuring, Display, Analysing and Recording Instruments- Working and Torque equations of PMMC, PMMI, Electrodynamometer. Digital Storage oscilloscope, LCD displays, Spectrum Analyzer, Peak response voltmeter, True RMS meter, Strip chart recorder, XY Plotter.	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	Illustrate the basic concepts and performance characteristics involved in a measurement system.	K2
CO2	Explain the principle and working of various transducers, measuring, display, analysing & recording instruments	K2
CO3	Identify the bridge circuits that can be used for measuring unknown values of passive devices.	K3
CO4	Select different transducers according to the required field of application.	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											3
CO2	3											3
CO3	3	3			3							3
CO4	3	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	Electronic Instrumentation and Measurements	David A Bell	Oxford	3 rd Edition, 2017
2	Sensors and Transducers	D. Patranabis	PHI learning Pvt Ltd	2 nd Edition, 2003
3	Electrical Measurements and Measuring systems	Golding E W and Widdis F C	Wheeler &co	1993
4	A Course in Electronic Measurements and Instrumentation	A K Shwany	Dhanpath Rai & Co	2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Electronic Instrument Design	Kim R Fowler	Oxford reprint	2015
2	Principles of measurement system	John Bentley	Pearson	4 th Edition
3	Electronic Instrumentation and Measurements	Kalsi HS	Mc Graw hill	4 th edition, 2019
4	Transducers & Instrumentation	D V S Murty	PHI learning Pvt Ltd	2 nd Edition, 2008
5	Introduction to Transducers	Arun K Ghosh	PHI learning Pvt Ltd	4 th edition, 2014

Video Links (NPTEL, SWAYAM...)	
	Link ID
NPTEL VIDEO: Sensors & Actuators	https://archive.nptel.ac.in/courses/108/108/108108147/

SEMESTER S6

BIOMEDICAL ENGINEERING

Course Code	OEAET612	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)	NIL	Course Type	Theory

Course Objectives:

1. To familiarize biomedical engineering and its applications.
2. To understand the physiology of major systems of the body for designing biomedical devices.
3. To impart knowledge about various biomedical devices.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to biomedical instrumentation system, overview of physiological systems - heart, lungs and muscles. Sources of bioelectric potential - Resting and action potential, propagation of action potentials. Bioelectric potentials (introduction only) - ECG, EEG, EMG, ERG, EOG and EGG. Electrode theory - Nernst relation. Bio potential electrodes - microelectrodes, skin surface electrodes and needle electrodes.	9
2	Overview of electro conduction system of the heart. Electrocardiography - ECG lead configurations, ECG recording system, Einthoven triangle, analysis of ECG signals. Measurement of blood pressure - Direct, indirect and relative methods, auscultatory method, oscillometric and ultrasonic non-invasive pressure measurement. Measurement of blood flow - Electromagnetic and ultrasonic blood flow meters.	9

3	Overview of the human nervous system, action potential of brain, brain waves, types of electrodes, placement of electrodes, evoked potential, EEG recording and analysis of EEG. Electromyography - Nerve conduction velocity, instrumentation system for EMG measurement. Overview of the physiology of respiratory system, Respiratory parameters, spirometer, body plethysmographs, gas exchange and distribution.	9
4	Therapeutic Equipments (Principle, block schematic diagram, working and applications) - Pacemakers, cardiac defibrillators, heart–lung machine, dialyzers, surgical diathermy equipment and ventilators. Medical Imaging systems (Basic Principle only) - X-ray imaging, properties and production of X-rays, computed tomography, Magnetic resonance imaging system and nuclear medicine system. Ultrasonic imaging system - introduction and basic principle. Colour doppler systems.	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	Describe the need and applications of biomedical instrumentation	K2
CO2	Understand the physiology of major systems of the body for designing biomedical devices.	K3
CO3	Illustrate the principle of patient monitoring and therapeutic systems	K2
CO4	Explain the principle of medical imaging techniques	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	2	3	3		3				3
CO2	3		3	2		3		3				3
CO3	3		3	2	3	3		3				3
CO4	3		3	2	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	Handbook of Biomedical Instrumentation	Khandpur R.S	McGraw-Hill	3 rd Edition, 2014
2	Medical Instrumentation: Application and Design	John G. Webster, Amit J. Nimunkar	WILEY	5 th Edition, 2020
3	Biomedical Instrumentation And Measurements	Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer	Pearson Education India	2 nd Edition, 2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Biomedical Instrumentation: The technology of the patient care	Barbara L. Christe	Cambridge University Press	2 nd Edition, 2017
2	Introduction to Biomedical equipment Technology	Joseph J.carr and John M. Brown	Wiley and Sons	4 th Edition, 2000
3	Principle of Biomedical Instrumentation and Measurement	Richard Aston	Merrill Education/Prentice Hall.	1 st Edition, 1990

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/108/105/108105101/
2	https://archive.nptel.ac.in/courses/108/105/108105101/ https://archive.nptel.ac.in/courses/102/105/102105090/
3	https://archive.nptel.ac.in/courses/108/105/108105101/ https://archive.nptel.ac.in/courses/102/105/102105090/
4	https://archive.nptel.ac.in/courses/102/105/102105090/

SEMESTER S6

MICROCONTROLLERS

Course Code	OEAET613	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)	-	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 8051 Microcontroller - 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 and 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.	8
3	Programming 8051 Using Assembly Language - Introduction to 8051 assembly language programming. Data types and 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 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.	10

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	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 (Mapping of Course Outcomes to Program Outcomes)

	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

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	The 8051 Microcontroller and Embedded Systems Using Assembly and C	Muhammad Ali Mazidi Janice Gillispie Mazidi 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...)	
	Link ID
NPTEL course I	Microprocessors and Microcontrollers - https://nptel.ac.in/courses/106108100
NPTEL course II	Microcontrollers and Applications - https://nptel.ac.in/courses/117104072

SEMESTER S6
POWER ELECTRONICS LAB

Course Code	PCAEL607	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)	PCAET503 Power Electronics	Course Type	Lab

Course Objectives:

1. To design and implement various power electronic circuits

Expt. No.	Experiments
Part A – Bread board/PCB (Minimum of 6 Experiments)	
1	Power BJT drive circuits
2	Power MOSFET drive circuits
3	Snubber circuits
4	Three phase diode bridge rectifier
5	Single phase Controlled rectifiers with R and RL loads
6	Realization of basic Buck, Boost and Buck-Boost converters
7	Application of PWM IC TL 494
8	DC to AC inverter using MOSFET & IC
9	Realization of simple SMPS
Part B – Should be done using SPICE/MATLAB/TINA-TI (Minimum of 6 Experiments)	
10	Drive circuits for Power BJT
11	Drive circuits for Power MOSFET
12	Snubber circuits – shunt and series
13	Three phase diode bridge rectifier
14	Single phase Controlled rectifiers with R and RL loads
15	Realization of Buck, Boost and Buck-Boost converters
16	Realization of Isolated Converters - Push-Pull, Half bridge and Full bridge configurations
17	DC to AC inverter using MOSFET

18	Realization of simple SMPS
19	DC motor speed control

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 demonstrate the functions of Power electronic circuits	K3
CO2	Design and simulate the functioning of power electronic circuits using simulation tools	K3
CO3	Function effectively as an individual and in a team to accomplish the given task	K3

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					3	3	2		3
CO2	3	3	3		3			3	3	2		3
CO3	2	2	2					3	3	2		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	Power Electronics (An Indian Adaptation): Converters, Applications and Design	Ned Mohan, Tore M. Undeland and William P. Robbins	Wiley	3 rd Edition, 2022
2	Power Electronics: Devices, Circuits, and Applications	M H Rashid	Pearson Education	4 th Edition, 2017

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 7

APPLIED ELECTRONICS AND INSTRUMENTATION

SEMESTER S7

ELECTRONIC DESIGN AUTOMATION

Course Code	PEAET741	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)	-	Course Type	Theory

Course Objectives:

1. To understand the algorithm behind electronic design automation based on graph theory
2. To familiarize algorithms used for partitioning and layout compaction in Integrated circuits
3. To equip with placement and routing algorithm used in VLSI industry

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Graph Terminology - Basic graph theory terminology, Data structures for representation of graphs. Graphs Search Algorithms - Breadth First Search, Depth First Search, Topological Sort. Shortest Path Algorithms - Dijkstra's Shortest Path Algorithm and Floyd Warshall Algorithm	9
2	Design Automation - VLSI Design Flow, VLSI Design Styles Partitioning Algorithms - Kernighan-Lin Algorithm, Fiduccia-Mattheyses Algorithm (Basic algorithmic description only) Layout - Layout Layers and Design Rules, Physical Design Optimizations	9
3	Compaction - Applications of Compaction Maximum Distance Constraints. Placement - Wirelength Estimation, Weighted Wirelength, Maximum Cut Size, Wire Density. Placement Algorithm - Quadratic Placement. Floor planning - Slicing Floorplan, Non-Slicing Floorplan Floorplan Representations - Constraint Graph, Sequence Pair	9

4	Global Routing - Terminology and Definitions	9
	Maze Routing Algorithm - Lee's Algorithm	
	Detailed Routing - Horizontal and Vertical Constraint Graph	
	Channel Routing Algorithm -Left-Edge algorithm	
	Basic concepts of Static Timing Analysis	

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 =24 Marks)	• 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 Search Algorithms and Shortest Path Algorithms to find various graph solutions.	K3
CO2	Outline VLSI Design Flow and Design Styles and apply partitioning algorithms on graphs representing netlist	K3
CO3	Illustrate Design Layout Rules and apply different algorithms for layout compaction	K3
CO4	Make use of various algorithms to solve placement, floorplan and routing problems	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	3	2		3							3
CO2	3	3	2		3							3
CO3	3	3	2		3							3
CO4	3	3	2	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	VLSI Physical Design: From Graph Partitioning to Timing Closure	Jin Hu, Jens Lienig, Igor L. Markov, Andrew B. Kahng	Springer	2011
2	Algorithms for VLSI Design Automation	Gerez, S abih H	John Wiley & Sons	2006
3	Algorithms for VLSI Physical Design Automation	Sherwani, Naveed A	Kluwer Academic Publishers,	1999

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	VLSI Physical Design Automation: Theory and Practice	Sadiq M. Sait and H. Youssef	World Scientific	1999
2	CMOS VLSI Design : A circuits and systems perspective	Neil H. E. Weste and David Money Harris	Pearson	4 th Edition, 2015
3	VLSI Design Methodology Development	Thomas Dillinger	Pearson	1 st Edition, 2020

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/106105161
2	https://nptel.ac.in/courses/106105161
3	https://nptel.ac.in/courses/106105161
4	https://nptel.ac.in/courses/106105161

SEMESTER S7

ELECTRIC VEHICLES AND RENEWABLE TECHNOLOGIES

Course Code	PEAET742	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)	None	Course Type	Theory

Course Objectives:

1. To familiarize Vehicle Performance and Propulsion Systems.
2. To Illustrate Energy Systems and Renewable Sources

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Conventional Vehicles - Basics of vehicle performance, Vehicle power source characterization, Transmission characteristics. Introduction to Electric Vehicles - History of electric vehicles, Classification of electric vehicles. Overview of EV challenges. Overview of EV technologies-motor drive technology, energy source technology, battery charging technology, vehicle-to-grid technology. Vehicle Dynamics & Load Forces - Mathematical models to describe vehicle performance, vehicle load forces: aerodynamic drag, rolling resistance, grading resistance, vehicle acceleration, Calculation of motor power from traction torque, Simple Numerical problems. Electric Drive-trains - Basic concept of electric traction, electric drive-train topologies (Basics only), Power flow control in electric drive-train topologies, Fuel efficiency analysis.(Derivations not required)	9
2	DC Drives - Motoring using a PM DC Machine - DC motor electric drive using DC-DC converter - Generating/Braking using a PM DC Machine. PMSM Drives - Review of PMSM motor basics – Independent control of orthogonal flux and torque (concept only)- Field Oriented Control (FOC) – Sensor based and sensorless control (block diagram only).	9

	Sizing the drive system - Matching the electric machine and the Internal Combustion Engine (ICE) , Sizing the propulsion motor, Sizing the power electronics-Switch technology selection, Ripple capacitor design, Switching frequency and PWM	
3	Battery based energy storage systems - Types of battery-battery parameters-units of battery energy storage - capacity rate, - cell voltage - specific energy - cycle life - self-discharge. Battery management system. Other storage topologies - Fuel Cell based energy storage systems-Supercapacitors - Hybridization of different energy storage devices. Overview of Electric Vehicle Battery Chargers –Types of chargers-On-board chargers, Off- board chargers, Wireless charger (Concept only). Electric Vehicle Supply Equipment (EVSE) - Grid to EVSE to On-board chargers to battery pack power flow block schematic diagrams – V2G concept. Introduction to AC and DC charging stations (Basics and Block diagram only). Types of Connectors - CHAdeMO, CCS Type1 and 2, GB/T.	9
4	Renewable Energy sources - World Energy Scenario, Indian Energy Scenario, Comparison of Conventional and Non-Conventional Energy Resources; Solar Energy: Introduction- Solar Photovoltaic –Solar Cell fundamentals, characteristics, cell efficiency, applications, Wind Energy– Introduction–Wind Turbine Types (HAWT and VAWT) - Wind power curve-Betz's Law-Power from a wind turbine, Tidal Energy –Principle of Tidal Power, Components of Tidal Power Plant (TPP), Classification of Tidal Power Plants, Advantages and Limitations of TPP.	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	Familiarise the performance of conventional vehicles and electric vehicles	K2
CO2	Analyse the various drive train topologies for electric vehicles	K3
CO3	Discuss the propulsion unit for electric vehicles and selection of drive systems	K3
CO4	Analyse the various energy storage systems and energy management strategies	K3
CO5	Illustrate the different renewable energy sources	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									3
CO2	3		2									3
CO3	3		2		2							3
CO4	3		2		2							3
CO5	3		2		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	Electric Vehicle Technology Explained	James Larminie and John Lowry,	Wiley	2 nd Edition, 2012
2	Electric and Hybrid Vehicles: Design Fundamentals	Iqbal Husain	CRC Press	2 nd Edition, 2010
3	Renewable Energy Sources and Emerging Technologies	D. P. Kothari, K. C. Singal and Rakesh Ranjan	PHI	3 rd Edition, 2021

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Elementary Concepts of Power Electronic Drives	K Sundareswaran	CRC Press	1 st Edition, 2019
2	Non-Conventional Energy Resources	Sawhney G. S.	PHI	1 st Edition, 2012
3	Sensored Field Oriented Control of 3-Phase Permanent Magnet Synchronous Motors (Application Notes)	Ramesh T Ramamoorthy, Brett Larimore, Manish Bhardwaj	TI	NA

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/108106170 https://archive.nptel.ac.in/courses/108/106/108106182/
2	https://nptel.ac.in/courses/108106170 https://archive.nptel.ac.in/courses/108/106/108106182/
3	https://archive.nptel.ac.in/courses/108/106/108106182/
4	https://archive.nptel.ac.in/courses/108/106/108106182/

SEMESTER S7
NON-LINEAR CONTROL SYSTEMS

Course Code	PEAET743	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)	-	Course Type	Theory

Course Objectives:

1. To understand non-linear system behaviour.
2. To perform stability analysis of non-linear control systems.
3. To design non-linear controllers.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction - Linear vs non-linear system, Common Nonlinearities in control systems, non-linear system behaviour, examples, Autonomous and non-autonomous systems, equilibrium points. Phase Plane Analysis - Singular points, construction of phase portraits, method of isoclines only, phase plane analysis of linear systems, phase plane analysis of non-linear systems, local behaviour of non-linear systems. Stability of limit cycles, Poincare, bendixon theorems.	9
2	Describing Function - Describing Function Fundamentals, Describing functions of common nonlinearities - hysteresis, backlash, relay, deadzone, saturation and combined effects. Application of describing function for stability analysis of autonomous system with single nonlinearity (relay, dead zone and saturation only).	9
3	Stability of nonlinear systems - Lyapunov theory (review) - autonomous and non-autonomous systems equilibrium points, Stability in the sense of Lyapunov, asymptotic stability and exponential stability, Linearization and local stability, Lyapunov's direct method, positive definite functions and Lyapunov functions, Lyapunov theorem for local stability and global stability.	9

	Analysis based on Lyapunov's direct method, LTI systems - simple problems.	
4	Krasovskii's method, Variable gradient method for constructing Lyapunov functions-simple examples, Popov's stability criterion. Non-Linear control system design-desired behaviour of nonlinear systems-Issues in constructing non-linear controllers- available methods of non-linear control design.	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	Illustrate Nonlinear System Behavior and Phase Plane Analysis	K3
CO2	Apply Describing Functions for Stability Analysis	K3
CO3	Evaluate System Stability Using Lyapunov Methods	K5
CO4	Design Nonlinear Controllers	K4

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	2	2									3
CO4	3	2	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	Control System Engineering	Nagarath I. J. and Gopal M.	New Age Publishers	6e, 2017
2	Applied Nonlinear Control	Jean Jacques Slotine and Weiping Li	Prentice Hall Inc	1991

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Nonlinear Systems	H. K. Khalil	Pearson Education	3/e, 2002
2	Nonlinear Systems: Analysis, Stability, and Control	Shankar Sastry	Springer	1999
3	Nonlinear and Optimal Control Systems	by Thomas L. Vincent, Walter J. Grantham	Wiley	1/e, 1997
4	Nonlinear Process Control	Michael Henson, Dale E. Seborg	Prentice Hall	1997

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/108/106/108106024/
2	https://archive.nptel.ac.in/courses/108/106/108106024/
3	https://archive.nptel.ac.in/courses/108/106/108106024/
4	https://archive.nptel.ac.in/courses/108/106/108106024/

SEMESTER S7

MOBILE ROBOTICS

Course Code	PEAET744	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)	-	Course Type	Theory

Course Objectives:

1. To familiarize types of locomotion and sensors for mobile Robots
2. To perform localization, path planning, kinematic modelling and control of mobile robots

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Legged locomotion - Leg configurations and stability, Examples of legged robot locomotion. Wheeled locomotion - conventional wheels, special wheels, drive types - Differential drive, Tricycle, Omnidirectional, Synchro drive, Ackerman steering, Skid steering. Case study - Basic simulation of a turtle bot in ROS, Building a Visual Robot Model with URDF from Scratch, Building a Movable Robot Model with URDF.	9
2	Sensors for Mobile Robots - Sensor classification, characterizing sensor performance, Wheel/motor sensors, Heading sensors, Ground-based beacons, Active ranging, Motion/speed sensors, Vision-based sensors. Representing Uncertainty in sensor measurements - Statistical representation, Error propagation - combining uncertain measurements. Case study - Adding sensors to the robot models in ROS	9
3	Robot Localization, Error propagation model, Probabilistic map-based localization - Kalman method, Other Examples of Localization Systems,	9

	Landmark-based navigation, Positioning beacon systems. Path planning of mobile robots - Road map, Cell decomposition, Potential field - Obstacle avoidance (Bug algorithm), Vector field histogram, Dynamic window approach Case study - Familiarization with 2D navigation stack, Basic ROS Navigation, Start robots in simulation	
4	Kinematic model of unicycle robot and differential drive robot, and car like mobile robot or steered robot. Control of mobile robots - Control of differential drive robot and steered robot based on its kinematic model. Case study (Overview only) - design and implementation of a differential drive robot capable of moving to a point, following a line and following a path. Case study - Control of a differential drive robot in ROS to move to a goal location	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 =24 marks)	- 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	Familiarize types of locomotion and sensors for mobile Robots	K2
CO2	Perform localization and path planning for mobile robots	K3
CO3	Develop kinematic model of mobile robots	K3
CO4	Control the mobile robots to follow different paths	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	3		3							3
CO2	3	2	3		3							3
CO3	3	2	3		3							3
CO4	3	2	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 Autonomous Mobile Robots	R. Siegwart, I. R. Nourbakhsh and Davide Scaramuzza	The MIT Press	2 nd Edition, 2011
2	Introduction to Mobile Robot Control	Spyros G. Tzafestas	Elsevier	1 st Edition, 2013
3	Robotics, Vision and Control: Fundamental Algorithms in MATLAB,	Peter Corke	Springer Tracts in Advanced Robotics,	2 nd Edition, 2017
4	Robot Operating Systems (ROS) for Absolute Beginners	Lentin Joseph and Aleena Johny	Apress	1 st Edition, 2018

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Learning ROS for Robotics Programming	Aaron Martinez and Enrique Fernández	Packt Publishing Ltd	2 nd Edition, 2015
2	Building Smart Robots Using ROS	Robin Tommy, Ajithkumar Narayanan Manaparampil and Rinu Michael	BPB	1 st Edition, 2022
3	Programming Robots with ROS: A Practical Introduction to the Robot Operating System	Morgan Quigley, Brian Gerkey, William D. Smart	O'Reilly	Greyscale Indian Edition, 2016
4	Modern Robotics: Mechanics, Planning, and Control	Kevin M. Lynch, Frank C. Park	Cambridge University Press	1 st Edition, 2017

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/112106298
2	https://nptel.ac.in/courses/112106298
3	https://nptel.ac.in/courses/112106298
4	https://nptel.ac.in/courses/112106298

SEMESTER S7

CRYPTOGRAPHY

Course Code	PEAET746	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)	-	Course Type	Theory

Course Objectives:

1. To introduce fundamental concepts of symmetric and asymmetric cipher models
2. To understand the basics of authentication

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Cryptography Introduction to cryptography, Need for cryptography, Kirchhoff's principle. Symmetric Cipher Models - Substitution techniques, Transposition techniques, Rotor machines, Steganography. Block Cipher - Design principles and modes of operation. The Data Encryption Standard, Strength of DES. Differential and linear Cryptanalysis	9
2	IDEA - Primitive operations, Key expansions, One round, odd round, Even Round, Inverse keys for decryption. AES - Basic Structure, Primitive operation, Inverse Cipher- Key Expansion, Rounds, Inverse Rounds. Stream Cipher –RC4	9
3	Number theory - Fundamental Theorem of arithmetic, Fermat's Theorem, Euler's Theorem, Euler's Totient Function, Extended Euclid's Algorithm, Modular arithmetic. Public key Cryptography - Principles of Public key Cryptography Systems,	9

	RSA algorithm. Key Management - Diffie-Hellman Key Exchange	
4	Basics of Elliptic curve cryptography Authentication - Authentication functions, Message authentication codes, Hash functions- SHA -1, Security of Hash functions and MACs. Introduction to Digital signatures - Digital signature standards	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	Summarize various encryption techniques	K2
CO2	Analyse the concepts in cryptographic algorithms	K4
CO3	Apply the principles of number theory in cryptographic algorithms for encryption/key exchange	K3
CO4	Illustrate authentication and digital signature schemes	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	3		3							3
CO2	3	3	3		3							3
CO3	3	3	3		3							3
CO4	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	Cryptography Engineering: Design Principles and Practical Applications	Niels Ferguson, Bruce Schneier, Tadayoshi Kohno	John Wiley & Sons	2 nd Edition, 2010
2	Cryptography and Network Security	Behrouz A. Forouzan and Debdeep Mukhopadhyay	McGraw Hill	3 rd Edition, 2015
3	Introduction to Cryptography with Coding Theory	Wade Trappe, Lawrence C. Washington	CRC Press	2 nd Edition, 2006

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Handbook of Applied Cryptography	Alfred Menezes, Paul C. van Oorschot, Scott A. Vanstone	CRC Press	5 th Edition, 2010
2	Cryptography: Theory and Practice	Douglas R. Stinson	Chapman and Hall/CRC	3 rd Edition, 2006
3	Guide to Elliptic Curve Cryptography	Hankerson, D.J., Menezes, A., Vanstone, S.A.	Springer	2004
4	Advanced Engineering Mathematics	Merle C. Potter, David C. Wiggert	Wiley	10 th Edition, 2012

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/106105162
2	https://nptel.ac.in/courses/106105162
3	https://nptel.ac.in/courses/106105162
4	https://nptel.ac.in/courses/106105162

SEMESTER S7
COMPUTER VISION

Course Code	PEAET745	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)	-	Course Type	Theory

Course Objectives:

1. To provide foundational knowledge and practical skills in traditional computer vision techniques, including image processing, feature extraction, and object recognition
2. To analyze and optimize visual data using classical algorithms and methods

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Overview of Computer Vision and Image Processing - Introduction to computer vision, applications, history, and challenges. Basics of image formation, pinhole camera model, image representation (grayscale, color spaces), and digital image properties (resolution, bit depth) Image filtering (smoothing, sharpening) and histogram processing	8
2	Feature Detection & Morphological Processing - Edge detection (Canny), Keypoint detection (Harris corner detector), blob detection and feature descriptors (SIFT, SURF) Basic morphological operations (erosion, dilation), opening, closing, boundary extraction, and applications in segmentation.	10
3	Image Segmentation and Object Detection - Thresholding methods (global, adaptive), region-based segmentation, clustering-based techniques (K-means, Mean Shift), and edge-based segmentation. Sliding window approach, Haar cascades, Histogram of Oriented Gradients (HOG), and template matching	8
4	Motion Analysis and 3D Vision - Background subtraction, frame differencing, temporal differencing, and basic optical flow concepts (Lucas-	10

	Kanade method). Tracking algorithms (Kalman filter, Mean Shift). Principles of stereo vision, epipolar geometry, disparity maps, depth estimation, Structure from Motion (SfM), camera calibration, and 3D reconstruction	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Internal Ex</i>	<i>Evaluate</i>	<i>Analyse</i>	<i>Total</i>
5	15	10	10	40

Criteria for Evaluation (Evaluate and Analyse): 20 marks

Evaluation Methods:

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

- Students should do minimum 3 experiments.
- Students will implement and analyze computer vision techniques using tools like OpenCV, Python/MATLAB.

2: Course Project (10 marks)

- Comprehensive project involving design, implementation, and analysis of computer vision techniques.
- Project phases - Proposal, Design, Implementation, Testing, Final Report, Presentation, and Viva Voce.

Experiments:

Experiment 1: Image Transformation and Filtering

Objective: Implement image transformations and filtering techniques.

Tools: OpenCV, Python / MATLAB.

Steps:

1. Apply image transformations (translation, rotation, scaling).
2. Perform image filtering (smoothing, sharpening).
3. Analyze the effects of different parameters on image processing results.

Experiment 2: Feature Detection and Description

Objective: Implement feature detection and description algorithms.

Tools: OpenCV, Python / MATLAB.

Steps:

1. Detect features using Harris corner detector, SIFT, and SURF.
2. Compare and analyze the effectiveness of different feature descriptors.

Experiment 3: Image Segmentation and Morphological Processing

Objective: Apply image segmentation and morphological processing techniques.

Tools: OpenCV, Python / MATLAB.

Steps:

1. Implement thresholding, region-based, and clustering-based segmentation.
2. Perform morphological operations (erosion, dilation).
3. Evaluate segmentation results and analyze applications.

Experiment 4: Object Detection and Tracking

Objective: Implement object detection and tracking techniques.

Tools: OpenCV, Python / MATLAB.

Steps:

1. Apply object detection methods (Haar cascades, HOG).
2. Implement tracking algorithms (Kalman filter, Mean Shift).
3. Visualize and analyze detection and tracking results.

Experiment 5: Stereo Vision and 3D Reconstruction

Objective: Perform stereo vision and 3D reconstruction.

Tools: OpenCV, Python/MATLAB.

Steps:

1. Compute disparity maps from stereo images.
2. Estimate depth and perform 3D reconstruction.
3. Analyze the accuracy and quality of 3D reconstruction

Sample Project Topics:

1. Developing a Real-Time Object Detection and Tracking System Using Traditional Computer Vision Techniques
2. Implementation of a Robust Image Segmentation Algorithm for Medical Imaging
3. Building a Stereo Vision System for Depth Estimation and 3D Reconstruction
4. Shape Analysis and Object Recognition Using Feature Descriptors
5. Motion Detection and Tracking in Surveillance Videos

Criteria for Evaluation: Lab Experiments (10 marks)

Understanding of Concepts (3 marks)

- Demonstrates a thorough understanding of the theoretical concepts related to the experiments.
- Correctly explains the purpose and expected outcomes.

Implementation and Accuracy (3 marks)

- Correctly implements the neural network models using appropriate tools.
- Ensures the design functions as expected with minimal errors.

Analysis and Problem-Solving (2 marks)

- Effectively analyzes the model performance and identifies issues.
- Demonstrates problem-solving skills in addressing challenges encountered during experiments.

Documentation and Reporting (1 mark)

- Provides detailed documentation of the experimental setup, process, and outcomes.
- Includes visualizations, code snippets, and analysis of results.

Presentation and Communication (1 mark)

- Clearly presents the experiments and their results.
- Able to answer questions and explain design choices.

Course Project (10 marks)**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.

Design and Implementation (3 marks)

- Implements the project design accurately using appropriate tools and techniques.
- The design is functional and meets the project objectives.

Innovation and Creativity (2 marks)

- Introduces innovative ideas or unique approaches in the design and implementation.
- Demonstrates creativity in solving problems or optimizing designs.

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 model.

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 =24marks)	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	Understand and explain the fundamental concepts of computer vision techniques.	K3
CO2	Implement and analyze various image processing and feature detection techniques.	K4
CO3	Apply and evaluate image segmentation, object detection, and tracking methods.	K5
CO4	Analyze and optimize 3D vision and motion analysis techniques, including structure from motion and shape analysis.	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
CO2	3	3	2	2	2							3
CO3	3	3	2	2	2							3
CO4	3	3	2	2	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	Computer Vision: Algorithms and Applications	Richard Szeliski	Springer	2022
2	Multiple View Geometry in Computer Vision	Richard Hartley, Andrew Zisserman	Cambridge University Press	2022
3	Digital Image Processing	Rafael C. Gonzalez, Richard E. Woods	Pearson	2023
4	Computer Vision: A Modern Approach	David L. Poole, Alan Mackworth	Prentice Hall	2023

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Handbook of Mathematical Models in Computer Vision	Nikos Paragios, Yunmei Chen, Oliver D Faugeras	Springer	2023
2	Image Processing, Analysis, and Machine Vision	Milan Sonka, Vaclav Hlavac, Roger Boyle	Cengage Learning	2022

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/106/105/106105216/
2	https://archive.nptel.ac.in/courses/106/105/106105216/
3	https://archive.nptel.ac.in/courses/106/105/106105216/
4	https://archive.nptel.ac.in/courses/106/105/106105216/

SEMESTER S7

INSTRUMENTATION SYSTEM DESIGN

Course Code	PEAET795	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)	PCAET602 Industrial Instrumentation, PCAET502 Process Dynamics and Control	Course Type	Theory

Course Objectives:

1. To impart knowledge on the design of signal conditioning circuits required for various sensors
2. To develop the skills needed to design transmitters, Analog/Digital PID controller, Data loggers and Alarm Annunciator
3. To familiarize with the design orifice and control valve sizing

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction and Standards Concepts of instrument design, functional requirements and specifications. Standards – Military, Industrial, and Commercial standards. BIS standards, ANSI standards, NEMA standards, DIN standards. Piping and Instrumentation Diagram P & I D Symbols, line numbering, line schedule, overview of various stages in P&I D development, P&I D for pumps, compressors process vessels, absorber and evaporator. Design of signal conditioning circuits Design of V/I Converter and I/V Converter, Signal conditioning circuit for pH electrodes, Design of Air-purge Level Measurement, Signal conditioning circuit for Thermocouple, RTD and Thermistor, Overview of Cold Junction Compensation and Linearization – software and Hardware approaches.	9

2	Design of Transmitters – Overview of 2 wire and 4 wire transmitters, Design of RTD based Temperature Transmitter, Thermocouple based Temperature Transmitter and Smart Transmitters. Control Valves - Characteristics, valve equation, types of valves- Globe valve, ball valve, gate valve, butterfly valve, needle valve, valve positioner, valve selection criteria.	9
3	Orifice and Control valve sizing - Orifice, Venturi and flow nozzle sizing - Liquid, Gas and steam services. Control valve sizing – Liquid, Gas and steam services. Overview of Rotameter Design Design of Data logger and PID controller Design of ON/OFF Controller using Linear Integrated Circuits, Electronic PID Controller, Basics of Microcontroller based digital two-degree of freedom PID Controller, Microcontroller based Data Logger, Basic architecture of PC based Data Acquisition Cards.	9
4	Control Panel Design Basics of operating console and control room panel design. Control room environment for electronic equipment - heat dissipation, forced air circulation and humidity considerations. Grounding and shielding- protection against electrostatic discharge. Design of Alarm and Annunciation circuit - Alarm and Annunciation Circuits using Analog and Digital Circuits – Design of Programmable Logic Controller for any two simple applications	9

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

Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Internal Ex</i>	<i>Evaluate</i>	<i>Analyse</i>	<i>Total</i>
5	15	10	10	40

Criteria for Evaluation (Evaluate and Analyse): 20 marks

- The project needs to be done as an individual project.
 - The project can be done as design and simulation or complete hardware implementation
 - Simulations may be done using tools like LabVIEW/MATLAB/Scilab
 - The students should design any one of the following systems with industrial standards
1. An industrial instrumentation system that can measure physical parameters like temperature, level, humidity or flow with P&I diagrams
 2. An industrial Data logger/ Data acquisition system
 3. Design and simulation of controllers suitable for various processes.
 4. A PLC based automation system.

At the completion of the project, the students should be familiar with the following:

- Select an appropriate components for measurement or control
- Interface various sensors/actuators to the digital systems
- Parameters to be considered while developing the system for industrial purposes
- Instrumentation drawings
- Use of simulation tools for industrial system design

The project deliverables consist of the following components:

- Detailed design specifications
- Identification and resolution of technical challenges
- Designed and developed algorithms
- Implementation results and performance evaluations
- Comprehensive project report, incorporating methodology, results, challenges, and recommendations.

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)	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 signal conditioning circuits for temperature sensors, V/I and I/V converters	K3
CO2	Design of transmitters, data logger, PID controller and alarm circuits	K3
CO3	Carry out orifice and control valve sizing for different services	K3
CO4	Design control panels	K3
CO5	Design automation systems with PLCs	K6

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									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	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	Instrument Engineers Handbook - Process Control and Optimization	Bela G. Liptak	CRC Press	4th Edition, Vol.2, 2008.
2	Introduction to Process Engineering and Design	Thakore and Bhatt	McGraw Hill	2 nd Edition, 2007
3	Process Control Instrumentation Technology	C. D. Johnson	Prentice Hall	8th Edition, 2015
4	Electronic Instrument Design	Kim Fowler	Oxford	Reprint 2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Principles of Measurement Systems	Bentley	Pearson Education	4 th Edition, 2015
2	Flow Measurement Engineering Handbook	R.W. Miller	McGraw Hill	1996.
3	Measurement Systems Application and Design	E.O. Dobelin	McGraw Hill	4 th Edition, 1989
4	Process/Industrial Instruments and Controls Handbook	Gregory K. McMillan, Douglas M. Considine	Mc Graw Hill	5th Edition, 1999
5	Hand Book of transducer	Harry N Norton	PHI	1 st Edition, 1989
6	A Course in Electronic Measurements and Instrumentation	A K Sawhney	Dhanpath Rai & Co	2021
7	Piping and Instrumentation Diagram Development	Moe Toghraei	Wiley	1 st Edition, 2019

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/108/105/108105064/
2	https://archive.nptel.ac.in/courses/108/105/108105064/
3	https://nptel.ac.in/courses/108105088
4	https://nptel.ac.in/courses/108105088

SEMESTER S7

POWER PLANT INSTRUMENTATION

Course Code	PEAET751	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)	-	Course Type	Theory

Course Objectives:

1. To introduce the basics of Power Generation.
2. To familiarize the various measurement techniques and control strategies adopted in Power Plants.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Power Plants - Brief survey of methods of power generation - hydro, nuclear, solar and wind power. Thermal Power Plant - Introduction to thermal power plant processes, building blocks, Boilers, Different Types – Pulverized Fuel Boiler. Importance of instrumentation in Power Generation.	9
2	Fuel Circuit (Basics only) - Furnace, Combustion Process, Fuel Systems, Pressurized Ball Mill, Air Preheater, Air Supply for Mills. Treatment of Flue Gases, Soot Blowers. Steam and Water Circuit - Steam Generation, Super heater, Attemperator, Reheater, Steam Turbine, Condenser, Cooling Tower, Deaerator, Economizer, Alternator, Feed Water Treatment	9
3	Measurement of non-electrical parameters in power plants - Metal temperature measurement, Pressure and Temperature measurement of Water and Steam, Drum Level Measurement, Smoke Density Measurement. Measurement of Electrical Parameters - Current, Voltage, Power, Frequency and Power Factor.	9

4	Introduction to turbine supervising system - Pedestal vibration, Shaft vibration, Eccentricity measurement. Installation of non-contacting transducers for speed measurement. Controls in Power Plants (Basics only) - Steam temperature control, Feed water Control, Boiler-following operation, Turbine – following operation, Co-ordinated unit control. Distributed control systems. Interlocks in boiler operation.	9
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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 basic principle behind different methods of Power Generation	K2
CO2	Summarize the working of a Thermal Power Plant	K2
CO3	Apply various techniques for measurement of electrical and non-electrical parameters in a thermal Power Plant	K3
CO4	Describe about the Turbine monitoring system and control strategies adopted in Power Plants	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									3
CO2	3	2	2									3
CO3	3	2	2		2							3
CO4	3	2	2		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	Power Plant Control and Instrumentation	David Lindsley	IET	1 st Edition, 2000
2	Modern Power Station Practice	P.C Martin, I.W Hannah	Pergamon Press, London	3 rd Edition, 1993
3	Power Plant Performance	A. B. Gill	Butterworths, London	1 st Edition, 1984

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Modern Power Station Practice – Volume F	M. W. Jervis	Pergamon Press, London.	3 rd Edition, 1991
2	The Control of Boilers	Sam G. Dukelow	ISA Press, New York	2 nd Edition, 1991

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/107/112107291/
2	https://archive.nptel.ac.in/courses/112/107/112107291/
3	https://archive.nptel.ac.in/courses/112/107/112107291/
4	https://archive.nptel.ac.in/courses/112/107/112107291/

SEMESTER S7

LOW POWER VLSI

Course Code	PEAET752	CIE Marks	40
Teaching Hours/Week (L:T:P:R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs 30 Mins
Prerequisites (if any)	GBPHT121 Physics for Electrical Science, PCAET302 Electronic Devices and Circuits	Course Type	Theory

Course Objectives:

1. To identify various sources of power dissipation and power reduction techniques in MOS devices.
2. To apply clocked and non-clocked design styles for logic circuit implementation.
3. To familiarize various adiabatic and reversible logic circuit implementations.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Sources of power dissipation in CMOS circuits Dynamic Power Dissipation - Charging and Discharging capacitance power dissipation. Short Circuit Power dissipation - Short Circuit Current of Inverter, Short circuit current dependency with input and output load, Glitching Power. Static Power Dissipation - Leakage Power Dissipation. Gate level power analysis - Capacitive, internal, and Static power dissipation of gate level circuit.	10
2	Power Reduction Techniques Supply voltage Scaling Approaches - Multi VDD and Dynamic VDD Leakage power reduction Techniques - Transistor stacking, VTCMOS, MTCMOS, DTCMOS, Dynamic power dissipation - Power gating, Clock gating, Transistor and Gate Sizing for Dynamic and Leakage Power Reduction.	8

3	Circuit design styles Clocked design style - Basic concept, Domino logic (domino NAND gate), Differential Current Switch Logic. Non-clocked circuit design style - fully complementary logic, NMOS and pseudo–NMOS logic, differential cascade voltage switch logic (DCVS)	9
4	Adiabatic switching Adiabatic charging, adiabatic amplification, One stage and two stage adiabatic buffer, Adiabatic logic gates, pulsed power supplies, Reversible logic basic concepts	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, one full question out of two questions need to be answered

Part A	Part B	Total
Total of 8 Questions (2 Questions from each module), 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	Model the capacitive, short circuit and leakage power dissipation in CMOS circuits	K3
CO2	Design lower power CMOS circuits by applying various techniques for power reduction	K3
CO3	Implement logic circuits using clocked and non-clocked design styles	K3
CO4	Implement the logic functions using adiabatic and reversible logic structures	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	3	3									3
CO2	3	3	3									3
CO3	3	3	3		2							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	Practical Low-Power Digital VLSI Design	Gray K. Yeap	Springer India	2008
2	Low-power CMOS VLSI Circuit Design	Kaushik Roy and Sharat C. Prasad	Wiley	2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Low-Power Digital VLSI Design: Circuits and Systems	Abdellatif Bellaouar, Mohamed Elmasry	Springer Science (Originally published by Kluwer Academic)	1995
2	Low Power Digital CMOS Design	Anantha P. Chandrakasan, Robert W. Brodersen	Kluwer Academic	2012
3	Low power CMOS circuits	Christian Piguet	Taylor and Francis	2018
4	Low Voltage, Low Power VLSI Subsystem	Kiat -Seng Yeo, Kaushik Roy	McGraw Hill Education	2017

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/106/105/106105034/
2	https://archive.nptel.ac.in/courses/106/105/106105034/
3	https://archive.nptel.ac.in/courses/106/105/106105034/
4	https://archive.nptel.ac.in/courses/106/105/106105034/

SEMESTER S7

LINEAR ALGEBRA IN AI AND ML

Course Code	PEAET753	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)	GYMAT101 Mathematics for Electrical Science-1, GYMAT201: Mathematics for Electrical Science-2	Course Type	Theory

Course Objectives:

1. To master matrix and vector operations for linear algebra computations
2. To use linear algebra in fields like engineering and data analysis, focusing on practical applications

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Linear Equations - Gaussian Elimination and Matrices, Ill-Conditioned Systems. Rectangular Systems and Echelon Forms - Row Echelon Form and Rank, Consistency of Linear Systems, Homogeneous Systems, Non homogeneous Systems. Matrix Algebra - Addition and Transposition, Linearity, Matrix Multiplication, Properties of Matrix Multiplication, Matrix Inversion, Inverses of Sum and Sensitivity, Elementary Matrices and Equivalence, The LU Factorization.	9
2	Vector Spaces - Spaces and Subspaces, Four Fundamental Subspaces, Linear Independence, Basis and Dimension, Classical Least Squares, Linear Transformations, Change of Basis and Similarity, Invariant Subspaces	9
3	Norms, Inner Products, and Orthogonality - Vector Norms, Matrix Norms, Inner-Product Spaces, Orthogonal Vectors, Gram-Schmidt Procedure, Unitary and Orthogonal Matrices, Orthogonal Reduction, Complementary Subspaces, Range-Null Space Decomposition, Orthogonal Decomposition, Singular Value Decomposition, Orthogonal Projection, Importance of Least Squares.	9

	Determinants - Properties of Determinants	
4	Eigenvalues and Eigenvectors - Elementary Properties of Eigensystems, Diagonalization by Similarity Transformations, Functions of Diagonalizable Matrices, Systems of Differential Equations, Normal Matrices, Positive Definite Matrices, Nilpotent Matrices and Jordan Structure, Jordan Form. Perron–Frobenius Theory - Positive Matrices, Non-negative Matrices, Stochastic Matrices and Markov Chains	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	Perform basic matrix operations, including addition, multiplication, and inversion, and analyze their properties and applications	K3
CO2	Apply methods such as Gaussian elimination and LU decomposition to solve linear systems and interpret the solutions	K3
CO3	Explore the concepts of vector spaces, linear independence, bases, and dimensions, and apply these to understand linear transformations and change of basis	K3
CO4	Compute eigenvalues and eigenvectors, use them to diagonalize matrices, and apply these concepts to solve practical problems in various fields	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	2								3
CO3	3	3	2	2								3
CO4	3	3	2	2	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	Matrix Analysis and Applied Linear Algebra	Carl D. Meyer	SIAM	2nd Edn. 2023

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	A Second Course in Linear Algebra	Stephan Ramon Garcia Roger A. Horn	Cambridge University press	1st Edn. 2017
2	Analysis and Linear Algebra: The Singular Value Decomposition and Applications	James Bisgard	American Mathematical Society	1st Edn. 2021
3	Introduction to Linear Algebra	Gilbert Strang	Wellesley-Cambridge Press,U.S.	6th Edn. 2023

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/111108066
2	https://nptel.ac.in/courses/111108066
3	https://nptel.ac.in/courses/111108066
4	https://nptel.ac.in/courses/111108066

SEMESTER S7

REAL TIME OPERATING SYSTEMS

Course Code	PEAET754	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)	PBECT404 Microcontrollers	Course Type	Theory

Course Objectives:

1. To identify the basic Operating System concepts and scheduling techniques
2. To familiarize Real-Time system characteristics and synchronization mechanisms
3. To familiarize and implement Real-Time task scheduling algorithms
4. To apply Real-Time operating systems in practical scenarios

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Operating Systems Objectives and Functions of Operating Systems, Types of OS, concept of the kernel within an operating system. Process Management - Process States, Process Control Block and Operations on process. Process Scheduling - Scheduling Algorithms – First Come First-Served (FCFS), Shortest Job First (SJF), Priority Scheduling, Round Robin (RR). Advanced Scheduling Techniques (Basics only) - Multilevel Queue Scheduling, Multilevel Feedback Queue Scheduling.	10
2	Real Time Operating Systems (RTOS) - Structure and characteristics of RTOS. Task Management - Task states and Task synchronization. Semaphores - Type, usage of semaphores for synchronization. Inter task communication mechanisms (Basics only) - message queues, pipes, event registers and signals.	8

3	Real-Time Task Scheduling and Constraints - Task Constraints. Task Scheduling - Aperiodic Task Scheduling (Jackson's Algorithm and Horn's Algorithm). Scheduling with Precedence Constraints - LDF and EDF. Periodic Task Scheduling (Basics only) - Rate Monotonic Scheduling (RMS), Deadline Monotonic Scheduling (DMS). Real-Time Kernel - Structure, State transition diagram and Kernel primitives.	9
4	Real-Time Operating Systems in Practice Feature and applications of FreeRTOS and Linux. Overview of commercial real-time operating systems - PSOS, VRTX and RT. Case Study - MicroC/OS-II (Features, threads and task scheduling basics only). Real-Life Applications - Adaptive cruise control - practical implementation challenges and solution.	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	Identify the functions of operating systems and solve process scheduling problems.	K3
CO2	Illustrate the different types of semaphores used for process synchronization and explain different inter task communication mechanisms.	K2
CO3	Model and solve aperiodic task scheduling problems by utilizing scheduling algorithms.	K4
CO4	Illustrate the implementation of a real time system.	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	3	3	3								3
CO2	3	3	3	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	Real-Time Concepts for Embedded Systems	Qing Li with Caroline Yao	CMP Books	1/e, 2003
2	Hard Real Time Computing Systems Predictable Scheduling Algorithms and Applications	Giorgio C. Buttazzo	Springer	3/e, 2011
3	Operating System	Rohit Khurana	Vikas	2/e, 2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Operating Systems Internals and Design Principles	William Stallings	Pearson	9/e, 2018
2	Operating System Concepts	Abraham Silberschatz	Wiley	10/e, 2018
3	MicroC/OS-II The Real-Time Kernel	Jean J Labrosse	CRC Press	2022

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/106/105/106105172/
2	https://archive.nptel.ac.in/courses/106/105/106105172/
3	https://archive.nptel.ac.in/courses/106/105/106105172/
4	https://archive.nptel.ac.in/courses/106/105/106105172/

SEMESTER S7

WIRELESS SENSOR NETWORKS

Course Code	PEAET756	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)	-	Course Type	Theory

Course Objective:

1. The course aims to expose students to computer networks taking a top-down approach of viewing from the layer of user applications and zooming into link layer protocols

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction, application, and challenges of wireless sensor networks (WSN). Wireless LANs and PANs - Introduction, Fundamentals of WLANs, IEEE 802.11 standard, HIPERLAN standard, Bluetooth. Wireless WANS and MANs (Basics only) - Cellular architecture, 2G/3G/4G/5G Cellular Networks, WLL. IEEE 802.15 Standard - Physical layer, Data link layer, MAC protocols. Wireless Internet.	9
2	Network architecture - Sensor network scenarios, Optimization goals and figures of merit, Design principles of WSNs, Service interfaces of WSNs. Communication Protocols - Physical layer - Wireless channel and communication fundamentals, Physical layer and transceiver design considerations in WSNs.	9
3	Mobile ad hoc networks and wireless sensor networks, Field buses and wireless sensor networks, Enabling technologies for wireless sensor networks. Mobile IP, TCP in wireless domain, TCP-BUS and Ad Hoc TCP, Split TCP, WAP, optimising Web over wireless.	9

4	WSN architecture - Single node architecture - Hardware components, Energy consumption of sensor nodes, Low power wireless sensor networks. Routing protocols (Basics only) - LEACH, PEGASIS and RPL. Overview of Operating systems and execution environments. Case Study (Basics only) - TinyOS and nesC.	9
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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 =24 marks)	• 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 principles of wireless networks concepts and their standards	K2
CO2	Illustrate various concepts on the basics of wireless sensor networks and mobile adhoc networks	K2
CO3	Develop single node wireless sensor architecture	K3
CO4	Analyse the network architecture and the communication protocols of wireless sensor networks	K4

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		2							3
CO2	3	2	2		2							3
CO3	3	2	2		2							3
CO4	3	2	2		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	Ad Hoc Wireless Networks: Architectures and Protocols	Siva Ram Murthy C. and Manoj B. S.	Pearson Education	2 nd Edition, 2005
2	Protocols and Architectures for Wireless Sensor Networks	Holger Karl and Andreas Willig	John Wiley	1 st Edition, 2007

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Wireless Communications and Networks	William Stallings	Prentice Hall	2 nd Edition, 2004
2	Fundamentals of Wireless Sensor Networks - Theory and Practice	Waltenegus Dargie , Christian Poellabauer	John Wiley	1 st Edition, 2010

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/106105160
2	https://nptel.ac.in/courses/106105160
3	https://nptel.ac.in/courses/106105160
4	https://nptel.ac.in/courses/106105160

SEMESTER S7

PATTERN RECOGNITION

Course Code	PEAET755	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 fundamental algorithms for pattern recognition
2. To instigate the various classification and clustering techniques

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basics of pattern recognition system – Introduction, various applications, classification of pattern recognition systems. Design of Pattern recognition system, Pattern recognition Life Cycle. Statistical Pattern Recognition - Review of probability theory, Gaussian distribution, Bayes decision theory and Classifiers, Optimal solutions for minimum error and minimum risk criteria, Normal density and discriminant functions, Decision surfaces.	9
2	Parameter estimation methods - Maximum-Likelihood estimation, Expectation-maximization method, Bayesian parameter estimation. Concept of feature extraction and dimensionality, Curse of dimensionality, Dimension reduction methods - Fisher discriminant analysis, Principal component analysis, Hidden Markov Models (HMM) basic concepts, Gaussian mixture models	9
3	Non-Parameter methods - Non-parametric techniques for density estimation - Parzen-window method, K-Nearest Neighbour method. Non-metric methods for pattern classification - Non-numeric data or	9

	nominal data. Decision trees, Concept of construction, splitting of nodes, choosing of attributes, overfitting, pruning. Linear Discriminant based algorithm - Perceptron	
4	Artificial Neural networks. Multilayer perceptrons, learning by gradient descent, Back Propagation algorithm. Classifier Ensembles: Bagging, Boosting/AdaBoost. Unsupervised learning - Clustering, Algorithms for clustering: K-means and Hierarchical methods, Cluster validation	9

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

Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Internal Ex</i>	<i>Evaluate</i>	<i>Analyse</i>	<i>Total</i>
5	15	10	10	40

Criteria for Evaluation (Evaluate and Analyze): 20 marks

- Each student should design, implement, and analyze a pattern recognition system for various applications.
- System development can be accomplished using
 - Python: OpenCV, NumPy, Scikit-image
 - MATLAB
- **Each student should do minimum four microprojects from basic level and two microprojects from advanced level.**

Basic Level

1. K-Nearest Neighbors (KNN) Classification:

- **Goal:** Classify iris species based on their measurements.
- **Approach:** Calculate the Euclidean distance between a new iris sample and all training samples. Classify the new sample based on the majority class of its k nearest neighbors.

2. Naive Bayes Classification:

- **Goal:** Predict the iris species based on its measurements.
- **Approach:** Assume independence between features and calculate the probability of each species given the feature values. Classify the new sample based on the highest probability.

3. Decision Tree Classification:

- **Goal:** Create a decision tree to classify iris species.
- **Approach:** Use algorithms like ID3 or C4.5 to construct a tree based on the features and their values. Classify new samples by traversing the tree.

4. Support Vector Machines (SVM) Classification:

- **Goal:** Find the optimal hyperplane to separate the iris species.
- **Approach:** Use SVM algorithms like linear SVM or kernel SVM to find the decision boundary. Classify new samples based on their position relative to the hyperplane.

5. Neural Network Classification:

- **Goal:** Train a neural network to classify iris species.
- **Approach:** Create a simple neural network with one or two hidden layers and train it using backpropagation. Classify new samples by feeding them to the trained network.

6. Feature Engineering and Visualization:

- **Goal:** Explore the relationships between features and visualize the data.
- **Approach:** Create visualizations like scatter plots, histograms, and box plots to understand the distribution of features and identify potential correlations. Experiment with feature engineering techniques to improve classification performance.

7. Ensemble Methods:

- **Goal:** Combine multiple classifiers to improve performance.
- **Approach:** Use methods like bagging, boosting, or stacking to create an ensemble classifier. Evaluate the performance of the ensemble compared to individual classifiers.

Advanced Level

1. K-Nearest Neighbors (KNN) for Image Classification:

- **Dataset:** MNIST dataset (handwritten digits)
- **Approach:** Calculate Euclidean distance between test image and all training images. Classify test image based on the majority class of its k nearest neighbors.
- **Learn:** Understand the concept of distance measures, nearest neighbors, and how they can be used for classification.

2. Naive Bayes for Text Classification:

- **Dataset:** IMDB dataset (movie reviews)
- **Approach:** Calculate the probability of a word belonging to a class and use Bayes' theorem to classify documents.
- **Learn:** Understand the concept of probability, conditional probability, and how Naive Bayes can be applied for text classification.

3. Decision Trees for Iris Classification:

- **Dataset:** Iris dataset (flower species)
- **Approach:** Construct a decision tree based on the features and their values. Classify test instances by traversing the tree.
- **Learn:** Understand the concept of decision trees, information gain, and how they can be used for classification.

4. Support Vector Machines (SVM) for Binary Classification:

- **Dataset:** Breast cancer dataset
- **Approach:** Find the optimal hyperplane that separates the classes. Classify test instances based on their position relative to the hyperplane.
- **Learn:** Understand the concept of margins, kernels, and how SVMs can be used for classification.

5. Perceptron for Binary Classification:

- **Dataset:** XOR dataset
- **Approach:** Implement a simple perceptron and train it to learn the XOR function.
- **Learn:** Understand the concept of neurons, weights, and how a perceptron can be used for classification.

6. Neural Networks for Image Classification:

- **Dataset:** MNIST dataset (handwritten digits)
- **Approach:** Implement a simple feedforward neural network with one or two hidden layers and train it using backpropagation.
- **Learn:** Understand the concept of neural networks, activation functions, backpropagation, and how they can be used for classification.

The project deliverables consist of the following components:

- Detailed design specifications
- Identification and resolution of technical challenges
- Designed and developed algorithms
- Implementation results and performance evaluations
- Comprehensive project report, incorporating methodology, results, challenges, and recommendations.

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 major approaches in statistical and syntactic pattern recognition	K2
CO2	Explain the various parameter estimation and pattern classification techniques	K2
CO3	Illustrate the basic concepts of ANN and unsupervised learning	K3
CO4	Design pattern recognition systems	K6

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	3	3								3
CO3	3	3	3	3								3
CO4	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	Pattern Recognition and Machine Learning	C M Bishop	Springer	1 st Edition, 2006
2	Pattern Classification and scene analysis	R O Duda, P.E. Hart and D.G. Stork	John Wiley	2 nd Edition, 2001

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Pattern Recognition Engineering	Morton Nadier and Eric Smith P	John Wiley & Sons, New York.	1 st Edition, 1993.
2	Pattern Recognition: Statistical, Structural and Neural Approaches.	Robert J. Schalkoff	John Wiley & Sons Inc., New York.	1 st Edition, 2007.
3	Pattern Recognition	S.Theodoridis and K. Koutroumbas	Academic Press.	4 th Edition, 2009.
4	Machine Learning	Tom Mitchell	McGraw-Hill	1 st Edition, 2017
5	Pattern Recognition Principles.	Tou and Gonzales	Wesley Publication Company, London.	1974.

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/117105101
2	https://nptel.ac.in/courses/117105101
3	https://nptel.ac.in/courses/117105101
4	https://nptel.ac.in/courses/117105101

SEMESTER S7

INTERNET OF THINGS BASED SYSTEM DESIGN

Course Code	PEAET785	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)	-	Course Type	Theory

Course Objectives:

1. To understand about the fundamentals of Internet of Things, its building blocks and their characteristics
2. To select suitable network architecture and use appropriate protocols for a given IoT application

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Internet of Things Definition, basic IoT block diagram, Characteristics of IoT devices – power, computational constraints. IoT Architecture – Middle ware based architecture and Service oriented architecture M2M Communication – M2M system model, device domain, network domain, application domain, M2M v/s IoT. Typical application areas of IoT – Smart homes, Agriculture and Smart city	9
2	IoT Hardware Commercially available sensors (Operating principles only) – Temperature and humidity sensor (DHT11/22), Gas Sensor (MQ series), Ultrasonic distance sensor (HC-SR04). Actuators (Working principles only) – DC motors, Solenoid based valves, electro-mechanical relay, solid state relay, stepper motors Embedded boards – Overview of typical microcontroller and single board	9

	computers boards used in IoT applications – Arduino Uno, ESP32, Raspberry Pi (Overview only)	
3	IoT Communication IoT device gateways, Overview of IP addressing – IPv4, IPv6. Network address translation (overview only) IoT infrastructure protocols (only overview and key features required) – RFID, Zigbee, Bluetooth, BLE, NFC, DASH7, LoRa, 6LoWPAN, SigFox, NB-IoT, WiFi. Overview of Cellular Communication for IoT (LTE 4G only)	9
4	Application Protocols and Cloud Computing (fundamental concepts only required) Message Queue Telemetry Transport (MQTT) – architecture, Quality of Service levels. HTTP REST API, Constrained Application Protocol (CoAP) – architecture, request-response model. Typical use cases of MQTT, CoAP and REST API in IoT networks. Cloud computing – overview of architecture. cloud models - Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS), and Infrastructure-as-a-Service (IaaS). Emerging Trends in IoT - AI Integration, 5G, and Beyond.	9

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

Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Internal Ex</i>	<i>Evaluate</i>	<i>Analyse</i>	<i>Total</i>
5	15	10	10	40

Criteria for Evaluation (Evaluate and Analyse): 20 marks

Evaluation Methods:

- Each student should develop an IoT based system
- The system developed should include IoT Protocols and web/smartphone based user interface/dashboard for controlling/monitoring the IoT based system
- The project details and the outcomes to be evaluated are as follows

Project: Design, simulate and realize an IoT based system

- Design Specifications
 - Detailed specifications of the system are to be made after conducting study of the place/facility where the system is to be deployed
- System design
 - Develop a block diagram of the system
 - Select sensors, actuators, embedded boards and power source required for the system
 - Select the communication protocol required for the system
- System development
 - Develop the code for the embedded components of the system
 - Develop the application code for IoT protocols (eg, MQTT, CoAP)
 - Develop the user interface/dashboard for controlling/monitoring the IoT based system
- Hardware implementation and integration of the system
 - Assemble the various hardware components of the system
 - Test the functionality of the system in a controlled environment
 - Deployment of the system in the field
 - Sensor data collection and analysis

Sample Projects:

- Home automation system
- Smart metering
- Logistics tracking
- Precision agriculture
- Air Quality Monitoring System
- Health Monitoring System

Evaluation parameters:

- Relevance of the project idea
- Design of the system
- Use of IoT protocols and web/smartphone based user interface
- Hardware Implementation and Testing
- Innovation and Creativity
- Final Report and Presentation

Project Deliverables:

1. Detailed design specifications of the IoT based system
2. Hardware implementation and deployment of the system in field condition
3. Comprehensive project report including methodology, results, challenges, and recommendations

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)	• 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 in a concise manner the architecture of IoT	K2
CO2	Identify various hardware components used in IoT	K3
CO3	Illustrate the various connectivity technologies and application protocols in IoT	K2
CO4	Design and develop IoT systems	K6

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	3									3
CO2	3	2	3									3
CO3	3	2	3									3
CO4	3	2	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 IoT	Sudeep. Misra, A. Mukherjee, and A. Roy	Cambridge University Press	1 st Edition, 2021
2	Internet of Things: A Hands-on Approach	Arshdeep Bahga and Vijay Madisetti	Orient Blackswan	1 st Edition, 2015
3	Internet of Things (IoT) Architecture and Design Principles	Raj Kamal	McGraw Hill	2 nd Edition, 2022

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	The Internet of Things	Samuel Greengard	The MIT Press Essential Knowledge Series	1st Edition, 2015
2	The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World	Michael Miller	QUE	2015
3	IoT Fundamentals	Hanes David, Salgueiro Gonzalo, Grossetete Patrick, Barton Rob, Henry Jerome	Pearson	1st Edition, 2017
4	Introduction to Industrial Internet of Things and Industry 4.0	Sudip Misra, Chandana Roy, Anandarup Mukherjee	CRC Press	1st Edition, 2020
5	Getting Started with the Internet of Things	Cuno Pfister	O'Reilly	1st Edition, 2011
6	Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystem	Ovidiu Vermesan, Peter Friess	River Publishers	1st Edition, 2013
7	Internet of things: A survey on enabling technologies, protocols, and applications.	A. Al-Fuqaha, M. Guizani, M. Mohammadi, M. Aledhari and M. Ayyash	IEEE Communications Surveys & Tutorials	2015

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/106/105/106105166/ https://online.stanford.edu/courses/xee100-introduction-internet-things
2	https://archive.nptel.ac.in/courses/106/105/106105166/ https://online.stanford.edu/courses/xee100-introduction-internet-things
3	https://archive.nptel.ac.in/courses/106/105/106105166/ https://online.stanford.edu/courses/xee100-introduction-internet-things
4	https://archive.nptel.ac.in/courses/106/105/106105166/ https://online.stanford.edu/courses/xee100-introduction-internet-things

SEMESTER S7

INTERNET OF THINGS

Course Code	OEAET721	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)	-	Course Type	Theory

Course Objectives:

1. To understand about the fundamentals of Internet of Things, its building blocks and their characteristics
2. To select suitable network architecture and use appropriate protocols for a given IoT application

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Internet of Things Definition, basic IoT block diagram, Characteristics of IoT devices – power, computational constraints. IoT Architecture – Middle ware based architecture and Service oriented architecture M2M Communication – M2M system model, device domain, network domain, application domain, M2M v/s IoT. Typical application areas of IoT – Smart homes, Agriculture and Smart city	9
2	IoT Hardware Commercially available sensors (Operating principles only) – Temperature and humidity sensor (DHT11/22), Gas Sensor (MQ series), Ultrasonic distance sensor (HC-SR04). Actuators (Working principles only) – DC motors, Solenoid based valves, electro-mechanical relay, solid state relay, stepper motors Embedded boards– Overview of typical microcontroller and single board computers boards used in IoT applications – Arduino Uno, ESP32, Raspberry Pi (Overview only)	9

3	IoT Communication IoT device gateways, Overview of IP addressing – IPv4, IPv6. Network address translation (overview only) IoT infrastructure protocols (only overview and key features required) – RFID, Zigbee, Bluetooth, BLE, NFC, DASH7, LoRa, 6LoWPAN, SigFox, NB-IoT, WiFi. Overview of Cellular Communication for IoT (LTE 4G only)	9
4	Application Protocols and Cloud Computing (fundamental concepts only required) Message Queue Telemetry Transport (MQTT) – architecture, Quality of Service levels. HTTP REST API, Constrained Application Protocol (CoAP) – architecture, request-response model. Typical use cases of MQTT, CoAP and REST API in IoT networks. Cloud computing – overview of architecture. cloud models - Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS), and Infrastructure-as-a-Service (IaaS). Basic overview of fog computing.	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 =24 Marks)	- 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 in a concise manner the architecture of IoT	K2
CO2	Identify various hardware components used in IoT	K3
CO3	Illustrate the various connectivity technologies in IoT	K2
CO4	Design and develop IoT systems	K3
CO5	Understand the fundamentals of cloud computing for IoT	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	3									3
CO2	3	2	3									3
CO3	3	2	3									3
CO4	3	2	3		3							3
CO5	3	2	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 IoT	Sudeep. Misra, A. Mukherjee, and A. Roy	Cambridge University Press	1 st Edition, 2021
2	Internet of Things: A Hands-on Approach	Arshdeep Bahga and Vijay Madisetti	Orient Blackswan	1 st Edition, 2015
3	Internet of Things (IoT) Architecture and Design Principles	Raj Kamal	McGraw Hill	2 nd Edition, 2022

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	The Internet of Things	Samuel Greengard	The MIT Press Essential Knowledge Series	1st Edition, 2015
2	The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World	Michael Miller	QUE	2015
3	IoT Fundamentals	Hanes David, Salgueiro Gonzalo, Grossetete Patrick, Barton Rob, Henry Jerome	Pearson	1st Edition, 2017
4	Introduction to Industrial Internet of Things and Industry 4.0	Sudip Misra, Chandana Roy, Anandarup Mukherjee	CRC Press	1st Edition, 2020
5	Getting Started with the Internet of Things	Cuno Pfister	O’Rielly	1st Edition, 2011
6	Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystem	Ovidiu Vermesan, Peter Friess	River Publishers	1st Edition, 2013
7	Internet of things: A survey on enabling technologies, protocols, and applications.	A. Al-Fuqaha, M. Guizani, M. Mohammadi, M. Aledhari and M. Ayyash	IEEE Communications Surveys & Tutorials	2015

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/106/105/106105166/ https://online.stanford.edu/courses/xee100-introduction-internet-things
2	https://archive.nptel.ac.in/courses/106/105/106105166/ https://online.stanford.edu/courses/xee100-introduction-internet-things
3	https://archive.nptel.ac.in/courses/106/105/106105166/ https://online.stanford.edu/courses/xee100-introduction-internet-things
4	https://archive.nptel.ac.in/courses/106/105/106105166/ https://online.stanford.edu/courses/xee100-introduction-internet-things

SEMESTER S7

MEMS

Course Code	OEAET722	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)	-	Course Type	Theory

Course Objectives:

1. To introduce the technology of micro electro mechanical systems
2. To understand the materials and manufacturing processes of MEMS

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	MEMS and Micro Systems – Introduction, Applications – multidisciplinary nature of MEMS. Principles and examples of Micro sensors and micro actuators – micro accelerometer, comb drives, Micro grippers – micro motors, micro valves, micro pumps, Shape Memory Alloys. Actuation and Sensing techniques - Thermal sensors and actuators, Electrostatic sensors and actuators, Piezoelectric sensors and actuators, magnetic actuators	10
2	Review of Mechanical concepts - Stress, Strain, Modulus of Elasticity, yield strength, ultimate strength – General stress strain relations – compliance matrix, Mechanical Properties of Silicon and Related Thin Films. Overview of commonly used mechanical structures in MEMS - Beams, Cantilevers, Plates, Diaphragms – Typical applications	8
3	Scaling laws in miniaturization - scaling in geometry, scaling in rigid body dynamics, Trimmer force scaling vector, scaling in electrostatic and electromagnetic forces, scaling in electricity and fluidic dynamics. Materials for MEMS - Silicon, Silicon compounds – Silicon Nitride, Silicon	9

	Dioxide, Poly Silicon, Silicon Piezo resistors. Polymers in MEMS – SU-8, PMMA, PDMS, Langmuir – Blodgett Films	
4	Micro System fabrication processes – Photolithography, Ion implantation, Diffusion, Oxidation, Chemical vapour deposition, Etching. Overview of Micro manufacturing – Bulk micro manufacturing, Surface micro machining, LIGA process, Basics of Micro system Packaging- Surface bonding, Anodic bonding	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 working principles of micro sensors and actuators	K2
CO2	Analyze and design the mechanical structures in MEMS	K3
CO3	Apply the scaling laws in the design of micro systems	K3
CO4	Understand the micro fabrication processes and MEMS materials	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	3	3	2								3
CO3	3	3	3	2								3
CO4	3	2	2	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	Foundations of MEMS	Chang Liu	Pearson	2/e, 2012
2	MEMS and Microsystems Design and Manufacture	Tai-Ran Hsu	TMH	1/e, 2002

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	VLSI Technology	Chang C Y and Sze S. M.	McGraw-Hill, New York	1/e, 2000
2	Microsensors: Principles and Applications	Julian W Gardner	John Wiley and sons	1/e, 1994
3	Fundamentals of Micro fabrication,	Mark Madou	CRC Press, Newyork	1/e, 1997
4	Microsystem design	Stephen D. Senturia	Springer(India)	2/e, 2006
5	Electromechanics and MEMS	Thomas B. Jones	Cambridge University Press	2/e, 2001

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/117105082
2	https://nptel.ac.in/courses/117105082
3	https://nptel.ac.in/courses/117105082
4	https://nptel.ac.in/courses/117105082

SEMESTER S7

EMBEDDED SYSTEMS

Course Code	OEAET723	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)	-	Course Type	Theory

Course Objectives:

1. To introduce the building blocks of Embedded System and various Embedded Development strategies
2. To impart knowledge of RTOS and processor scheduling algorithms

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Embedded Systems Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems	9
2	Typical Embedded System Core of the Embedded System – General Purpose and Domain Specific Processors – ASICs, PLDs, Commercial Off-The-Shelf Components (COTS). Memory – ROM, RAM, Memory according to the type of Interface, Memory selection for Embedded Systems, Introduction to sensors and Actuators for Embedded Systems	9
3	RTOS Based Embedded System Design Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multi processing and Multi-tasking, Task Scheduling.	9

	Basics of Task Communication – Shared Memory, Message Passing. How to Choose an RTOS	
4	Embedded System Development Process Overview of embedded system development process – Waterfall model and spiral model. Requirements analysis, System Architecture design, Selection of processor, development platform and tools selection, coding issues and code optimization basics of testing and debugging. Introduction to verification and validation	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 fundamental embedded systems design paradigms, architectures, possibilities and challenges	K2
CO2	Analyze the sub systems of an embedded system and their interaction in the functionality of the embedded systems	K2
CO3	Practically apply gained theoretical knowledge to develop embedded systems	K3
CO4	Apply formal techniques of simulation, testing, verification and validation in designing reliable and safe embedded 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	2	3		3							3
CO2	3		3		3							3
CO3	3	2	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 Embedded Systems	Shibu K. V	Tata McGraw Hill	2 nd Edition, 2017
2	Embedded System Design – A unified hardware/software Introduction	Frank Vahid, Tony Givargis	John Wiley	2006
3	Embedded Systems- Architecture, Programming and Design	Raj Kamal	Tata McGraw Hill	3 rd Edition, 2017
4	Embedded Systems: An Integrated Approach	Lyla B. Das	Pearson	1 st Edition, 2012

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Embedded System Design	Steve Heath	Elsevier/ Newnes	2 nd Edition, 2002
2	Embedded Microcontrollers and Processor Design	Greg Osborn	Pearson	2011
3	Embedded Microcomputer Systems – Real Time Interfacing	Jonathan W. Valvano	Cengage Learning	2rd Edition, 2011

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/108102045
2	https://nptel.ac.in/courses/108102045
3	https://nptel.ac.in/courses/108102045 https://archive.nptel.ac.in/courses/106/105/106105172/
4	https://nptel.ac.in/courses/108102045 https://archive.nptel.ac.in/courses/106/105/106105172/

SEMESTER 8

APPLIED ELECTRONICS AND INSTRUMENTATION

SEMESTER S8

INSTRUMENTATION IN PETROCHEMICAL INDUSTRIES

Course Code	PEAET861	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)	PCAET602 Industrial Instrumentation	Course Type	Theory

Course Objectives:

1. To analyze the origin, characteristics and processing of petroleum.
2. To illustrate the sensors, instruments, control systems and safety aspects in the petroleum industry

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Petroleum Industry Overview of the Petroleum Industry - Origin of Petroleum, source rock and maturation, Oil and gas traps, physical and chemical characteristics of crude oil, migration mechanism, basics of reservoir rock and cap rocks, Overview of refinery processing and refinery products. Processes in Petroleum Industry (Basics only) - Atmospheric Distillation of crude oil, Vacuum Distillation of crude oil, Thermal processes (coking, visbreaking), and Catalytic processes (catalytic cracking).	9
2	Instrumentation and Control in Petroleum Industry P & I Symbols - Overview and symbols of process lines, process equipment, instrument bubbles, valve types, piping and heat exchanger. P & I diagram of Petroleum Refinery. Overview of Control Systems - Feedback, Feed-forward Control and cascade. Importance of instrumentation in the petroleum sector Pressure measurement - Types of pressure (Gauge, absolute, differential), Overview of pressure sensors (Bourdon tube, diaphragm, capsule, strain gauge), Pressure Transmitters and their Calibration, Control Valves and Pressure Controllers	9

3	Measurements in Petroleum Industry Temperature Measurement – Infrared Temperature Sensor, Temperature Transmitters, Thermowells and Temperature Controllers. Applications of temperature measurement in Petrochemical Processes. Flow Measurement - Types of Flow Meters (Electromagnetic, Ultrasonic, Coriolis), Basics of Flow Transmitters and Controllers, Flow Control Applications in Piping and Distribution Systems. Level Measurement (basics only) - Types of sensors (Capacitive, radar, and float-based sensors), Overview of Level Controllers and Switches, Applications of level sensors (storage tanks, reactors and separators).	9
4	Analytical Instrumentation and Safety in Petroleum Industry Introduction to Process Analyzers - Gas Chromatography, Spectroscopy, pH, and Conductivity Analyzers. Application of Analyzers in Petrochemical Industries, Integration of Analytical Instruments with Control Systems. Safety Instrumented Systems (SIS) and Standards – Basics of Safety Instrumented Systems and Safety Integrity Levels (SIL), Overview of IEC 61511 Standard for Functional Safety, Instrumentation for Safety: Emergency Shutdown Systems (ESD), Fire and Gas Detection Systems, Implementation and Maintenance of SIS in Petrochemical Plants.	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	Analyze the origin, characteristics and processing of petroleum	K2
CO2	Illustrate and analyse process systems using P & I Diagram	K3
CO3	Familiarise pressure, level and temperature measurements and control systems in the petroleum industry	K3
CO4	Understand the safety aspects in the petroleum industry	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		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	Fundamentals of Petroleum Refining	Mohamed A. Fahim, Taher A. Al-Sahhaf, and Amal El-Halwagi,	Elsevier	1 st Edition, 2009
2	Process Control: Instrumentation Technology	Curtis D. Johnson	Pearson	8 th Edition, 2005
3	Chemical Process Control: An Introduction to Theory and Practice	George Stephanopoulos	Pearson	1 st Edition, 2015
4	Kenexis Safety Instrumented Systems Engineering Handbook	Kevin J. Mitchell, Todd M. Longendelpher, Matthew C. Kuhn	Kenexis	1 st Edition, 2010

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction To Petroleum Exploration And Engineering	Andrew Clennel Palmer	World Scientific Publishing	1 st Edition, 2016
2	Instrument Engineers' Handbook: Process Measurement and Analysis (Volume 1)	Bela G. Liptak	CRC Press	4 th Edition, 2003
3	Measurement and Control Basics	Thomas A. Hughes	ISA Press	3 rd Edition, 2002
4	Safety Instrumented Systems: Design, Analysis and Justification	Paul Gruhn and Harry L. Cheddie	ISA Press	2 nd Edition, 2005

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/103105221
2	https://nptel.ac.in/courses/103105221 https://nptel.ac.in/courses/108105064 https://archive.nptel.ac.in/courses/103/105/103105130/
3	https://nptel.ac.in/courses/108105064 https://archive.nptel.ac.in/courses/103/105/103105130/
4	https://nptel.ac.in/courses/108105064 https://archive.nptel.ac.in/courses/103/105/103105130/

SEMESTER S8

INDUSTRY 4.0

Course Code	PEAET862	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)	-	Course Type	Theory

Course Objectives:

1. To familiarize Industrial IoT and Industry 4.0
2. To understand various enabling technologies and trends in Industry 4.0

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Industry 4.0 Overview and evolution of Industry 4.0, Key aspects and components of Industry 4.0. Industrial IoT (IIoT) – Introduction, IIoT reference architecture, overview of three tier topology of IIoT (edge tier, platform tier and enterprise tier) Basics of cyber physical systems (CPS), CPS and IIoT, Applications of IIoT Industrial Internet Systems (IIS) – Fundamentals, elements of IIS (analytics, intelligent machines and connected people). Applications of Industry 4.0.	9
2	Enabling Technologies in Industry 4.0. Smart factories – Introduction, characteristics of smart factories, benefits, smart factories versus traditional factories. Industrial sensing – Smart sensors, enhanced sensors (virtual sensors, self-calibration, self-testing, self-learning), introduction to tool condition monitoring.	10

	Introduction to customized and modular robotic systems (basics only), Additive Manufacturing (AM) - Introduction, The general AM process chain, advantages and limitations of AM. Advantages of 3D printing technology for Industry 4.0	
3	Big Data and AI in Industry 4.0 Big Data – Introduction, characteristics of big data, big data sources, big data acquisition and storage, necessity of big data analytics (basics only). Machine learning and artificial intelligence for industry 4.0 (overview only), applications of ML in industries. Blockchain for Industry 4.0 – Introduction, challenges for blockchain implementation.	9
4	Recent Trends Data Security (basics only) – types of cyber security threats, Need for security in IIoT (software security, network security, mobile device security) Introduction to Cloud Computing for Industry 4.0 (Overview and advantages only). Introduction to Smart supply chain management - Advantages of IIoT in inventory management. Introduction to Industry 5.0. Case study (application and benefits of IIoT only) – Manufacturing industry and Automotive industry.	8

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	Illustrate the fundamentals of Industrial IoT and Industry 4.0	K2
CO2	Understand the enabling technologies for Industry 4.0	K2
CO3	Apply machine learning and big data for Industry 4.0	K3
CO4	Explain the cloud computing and security issues.	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	3		3							3
CO2	3	2	3		3							3
CO3	3	2	3		3							3
CO4	3	2	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	Industry 4.0: Concepts, Processes and Systems	Ravi Kant and Hema Gurung	CRC Press	1 st Edition, 2024
2	Introduction to Industrial Internet of Things and Industry 4.0	Sudip Misra, Chandana Roy, Anadarup Mukherjee	CRC Press	1 st Edition, 2021
3	Industry 4.0: The Industrial Internet of Things	Alasdair Gilchrist	APress	1 st Edition, 2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Industrial IoT Application Architecture and Use Cases	Suresh, Malarvizhi Nandagopal, Pethuru Raj, E. A. Neeba, Jenn Wei Lin	CRC Press	1 st Edition, 2020
2	Hands On Industrial Internet of Things	Giacomo Veneri and Antonio Capasso	Packt	1 st Edition, 2018
3	Industrial Internet of Things: Technologies and Research Directions	Anand Sharma, Sunil Kumar Jangir, Manish Kumar, Dilip Kumar Choubey, Tarun Shrivastava, S. Balamurugan	CRC Press	1 st Edition, 2022
4	5G-Enabled Industrial IoT Networks	Amitava Ghosh, Rapeepat Ratasuk, Peter Rost, Simone Redana	Artech House	1 st Edition, 2022
5	IoT Product Design and Development: Best Practices for Industrial, Consumer, and Business Applications	Ahmad Fattahi	Wiley	1 st Edition, 2023
6	Industrial Internet of Things (IIoT): Intelligent Analytics for Predictive Maintenance	R. Anandan, S. Gopalakrishnan, Souvik Pal and Noor Zaman	Wiley	1 st Edition, 2022
7	Technology for People: Industry 5.0 = Industry 4.0 + Society 5.0	Mune Moğol Sever	Literaturk Academia	1 st Edition, 2024

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/106105195
2	https://nptel.ac.in/courses/106105195
3	https://nptel.ac.in/courses/106105195
4	https://nptel.ac.in/courses/106105195

SEMESTER S8

AEROSPACE INSTRUMENTATION

Course Code	PEAET863	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)	-	Course Type	Theory

Course Objectives:

1. To develop a comprehensive understanding of the fundamental principles and instruments in aerospace engineering and aerodynamics
2. To attain knowledge in aircraft and space vehicle instrumentation, navigation systems and advanced technologies used in modern aerospace operations

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Aerospace Engineering and Aerodynamics History of aviation and space flight, Anatomy of airplanes and space vehicles, Fundamentals of aerodynamics, Airfoil nomenclature, Lift and drag concepts, Types of drag. Finite wings and swept wings, Flaps and control surfaces. Basic aircraft performance parameters - Thrust and power, Rate of climb, Ceiling (absolute and service), Range and endurance	9
2	Propulsion Systems and Space Vehicle Dynamics Aircraft propulsion - Introduction to turbojet, turbofan and ramjet engines. Basic engine instrument - Fuel content gauges. Space vehicle propulsion - Rocket engines and propellants, Staging concepts. Space vehicle trajectories - Kepler's laws, Basics of Orbital mechanics. Introduction to guidance, navigation and avionics.	9
3	Aircraft Instruments and Navigation Systems Atmospheric measurements - Standard atmosphere, Altimeters (aneroid and	9

	radio), Air speed indicators and Mach meters, Heading indicator. Aircraft compass systems - Magnetic compass, Remote indicating magnetic compass. Pitot - static system, Rate of climb indicator, Attitude indicator, Integrated flight instruments. Radio navigational aids (Basic concepts only) - Automatic direction finder, VHF direction finder.	
4	Advanced Navigation and Inertial Sensors Global Navigation Satellite Systems (GNSS) and GPS Inertial navigation systems – Principles and components. Gyroscopes - Principles and types (Ring laser gyroscope, Fiber optic gyroscope, MEMS gyroscopes). Accelerometers – Basic Principles, MEMS accelerometers. IFR and VFR, Introduction to Automatic pilots and flight control systems.	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 fundamental principles of aerodynamics, aircraft performance, and propulsion systems in aerospace engineering	K2
CO2	Analyze the working principles and applications of various aircraft instruments and navigation systems used in aerospace	K3
CO3	Evaluate advanced navigation technologies and inertial sensors employed in modern aerospace systems	K3
CO4	Demonstrate basic instrumentation systems for aerospace applications	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	2	3							3
CO2	3		3	2	3							3
CO3	3		3	2	3							3
CO4	3		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	Aircraft Instruments and Integrated Systems	E.H.J. Pallett	Pearson Education India	1 st Edition, 1992
2	Elements of Electronic Navigation	N.S. Nagaraja	Tata McGraw Hill	2 nd Edition, 2017
3	Avionics: Fundamentals of Aircraft Electronics	Scott Kenney	Avotek Information Resources	1 st Edition, 2013

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Aerospace Engineering with a Flight Test Perspective	Stephen Corda	Wiley India	1 st Edition, 2017
2	Flight Mechanics: Theory of Flight Paths	Angelo Miele	Dover Publications	1 st Edition, 2016
3	Measurement Systems: Application and Design	Ernest O. Doebelin and Dhanesh N. Manik	Tata McGraw Hill	4 th Edition, 1989

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/101/101/101101079/ https://archive.nptel.ac.in/courses/101/105/101105059/
2	https://archive.nptel.ac.in/courses/101/101/101101001/
3	https://archive.nptel.ac.in/courses/101/104/101104062/
4	https://archive.nptel.ac.in/courses/101/108/101108056/

SEMESTER S8

MEMS AND NANOELECTRONICS

Course Code	PEAET864	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)	-	Course Type	Theory

Course Objectives:

1. To understand the materials and technology of MEMS
2. To understand the basic principles of nanoelectronics

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction - Overview of Nano and Microelectromechanical Systems, Applications of Micro and Nanoelectromechanical systems. MEMS - Definition, devices and structures. Materials for MEMS - Silicon, Silicon compounds – Silicon Nitride, Silicon Dioxide, Poly Silicon, Silicon Piezo resistors. Polymers in MEMS – SU-8, PMMA, PDMS, Langmuir – Blodgett Films. Stress-strain relationship and mechanical properties of Silicon	8
2	Microsystem fabrication processes - Photolithography, Ion Implantation, Diffusion and Oxidation. Thin film depositions - LPCVD, Sputtering, Evaporation, Electroplating. Etching techniques - Dry and wet etching, electrochemical etching. Micromachining - Bulk Micromachining, Surface Micromachining, High Aspect-Ratio (LIGA and LIGA-like) Technology	10
3	MEMS Sensors - Design of Acoustic wave sensors, resonant sensor, Vibratory gyroscope, Capacitive and Piezo Resistive Pressure sensors. Micro Actuator - Design of Actuators, Actuations using thermal forces, shape memory Alloys, piezoelectric crystals, Electrostatic forces (Parallel plate, Comb drive actuators), Micromechanical pumps	9

4	Nanoelectronics and Quantum Mechanics - Atomic Structures and Quantum Mechanics Basics of Molecular and Nanostructure Dynamics - Schrodinger Equation and Wave function Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Molecular Wires and Molecular Circuits	9
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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 basic principles of MEMS and Nano structures	K2
CO2	Understand the fabrication technology of MEMS structures	K2
CO3	Design MEMS sensors and actuators	K3
CO4	Illustrate the technology of nanoelectronics and quantum dynamics.	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	3	2								3
CO2	3	3	3	2								3
CO3	3	3	3	2								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	MEMS and NEMS: Systems, Devices, and Structures	Sergey Edward Lyshevski	CRC Press	1/e, 2002
2	Fundamentals of Micro fabrication	Mark Madou	CRC Press, Newyork	1/e, 1997

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	VLSI Technology	Chang C Y and Sze S. M.	McGraw-Hill, New York	1/e, 2000
2	Microsensors: Principles and Applications	Julian W Gardner	John Wiley and sons	1/e, 1994
3	Microsystem design	Stephen D. Senturia,	Springer(India)	2/e, 2006
4	Foundations of MEMS	Chang Liu	Pearson	2/e, 2012
5	MEMS and Microsystems Design and Manufacture	Tai-Ran Hsu,	TMH	1/e, 2002
6	Principles of Quantum Mechanics	A M Dirac	Oxford University Presss	1/e, 1978

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/117105082
2	https://nptel.ac.in/courses/117105082
3	https://nptel.ac.in/courses/117105082
4	https://nptel.ac.in/courses/117105082

SEMESTER S8

WAVELETS AND MULTIRATE ANALYSIS

Course Code	PEAET866	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)	PBECT504 Digital Signal Processing	Course Type	Theory

Course Objectives:

1. To have sufficient understanding of multirate operations and design of filter banks for signal processing applications.
2. To familiarize with wavelet transform of signals, construction of wavelets, filter bank implementation and practical applications

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Multirate Systems and Filter banks Introduction to multirate signal processing and its applications. Multirate system fundamentals - Basic multi-rate operations - up sampling and down sampling, Time domain and Frequency domain analysis, Need for anti aliasing and anti imaging filters. Noble identities. Fractional sampling rate alteration. Type 1 and Type 2 Polyphase decomposition, Efficient structures for decimation and interpolation filters. Introduction to Digital Filter Banks, Efficient implementation, Two Channel Quadrature Mirror Filterbank (QMF), Perfect Reconstruction.	9
2	Time - Frequency analysis of signals and Wavelet Transform Time - frequency analysis of signals - Spectral analysis of signals, Spectral leakage by windowing effect, Time and frequency localization of signals, the Uncertainty Principle and its implications. Short Time Fourier transform – Continuous time and discrete time STFT, Filter bank implementation of STFT. Continuous wavelet transform – Concept of wavelets, CWT for signal	9

	analysis, Condition of admissibility and its implications, Inverse Continuous Wavelet Transform, Properties of CWT.	
3	Discrete Wavelet Transform and filter bank implementation Discrete Wavelet Transform – Concept of DWT, Time frequency tiling of DWT and comparison to STFT. Haar Scaling and Wavelet functions, Function Spaces, Refinement relation, Wavelet decomposition of signals. Designing orthogonal wavelet systems- Relation of DWT to filter banks for signal decomposition and reconstruction Multi resolution Analysis (MRA) - Concept of MRA and relating it to filter banks. Computation of DWT using Mallat Algorithm and Lifting Scheme.	9
4	Wavelet Transform applications Wavelet Transform applications in image processing – Wavelet Transform of images, Wavelet Transform based Image compression, EZW Coding. Applications of Wavelet Transform in image denoising, edge detection and object detection. Wavelet Transform applications in audio processing - Application of wavelets in audio compression, Wavelet based audio coding.	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 =24 marks)	• 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 concepts and interconnection of multirate systems to identify the efficient realization of filter banks using polyphase decomposition and multirate identities.	K3
CO2	Explain the principles of Short Time Fourier Transform and Wavelet Transform, taking into consideration the time frequency analysis of signals.	K3
CO3	Illustrate filter bank implementation of wavelet transform to be used in multi resolution analysis for signal processing applications	K3
CO4	Examine the use of wavelet transforms for applications involving image and audio processing.	K4
CO5	Understand the concepts and interconnection of multirate systems to identify the efficient realization of filter banks using polyphase decomposition and multirate identities.	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	3	3	2	2	2						3
CO2	3	3	3	2	2	2						3
CO3	3	3	3	2	2	2						3
CO4	3	3	3	2	2	2						3
CO5	3	3	3	2	2	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	Multirate Systems and Filter Banks	P. Vaidyanathan	Pearson Education	1/e 2006
2	Insight Into Wavelets: From Theory to Practice	K.P. Soman, K.I. Ramachandran, N.G. Resmi	Prentice Hall	3/e 2010

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Digital Signal Processing: A computer based approach	Sanjith K Mitra	Tata-McGraw Hill	4/e 2013
2	Digital Signal Processing. Principles, Algorithms and Applications	John G. Proakis, Dimitris G. Manolakis.	Pearson Education	4/e 2007
3	Wavelets and Filter banks	Gilbert Strang and Truong Q. Nguyen	Wellesley- Cambridge Press	2/e 1996
4	Wavelet Transforms: Introduction to Theory and Applications	Raghuveer M. Rao, Ajit S. Bopardikar	Prentice Hall	1/e 1998
5	Wavelets and sub band coding,	M. Vetterli & J. Kovacevic	Prentice Hall	1/e 1995

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/108/106/108106136/
2	https://nptel.ac.in/courses/117101001
3	https://nptel.ac.in/courses/117101001
4	https://nptel.ac.in/courses/117101001

SEMESTER S8

DEEP LEARNING

Course Code	PEAET865	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)	-	Course Type	Theory

Course Objectives:

1. To provide foundational knowledge of advanced neural network architectures like CNNs, RNNs, and generative models.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to ANN and CNN Overview of biological neuron, concept of Perceptrons, Multi-Layer Perceptrons (MLPs) Activation functions - Sigmoid Relu and Softmax. Loss functions-Mean Squared Error, Cross Entropy Convolutional Neural Networks - Convolution operation. CNN Architecture - convolutional layers, kernels, padding, pooling layers, fully connected layers.	9
2	Training CNNs - Back-propagation and initialization Optimization algorithms - SGD, Adam Hyper parameter optimization-Learning rate Regularization methods - L1, L2 regularization, dropout, Data Augmentation, Early stopping, batch normalization Introduction to Transfer learning.	9
3	Sequence Models Recurrent Neural Networks (RNN) - cell structure and architecture. Training RNN - back propagation through time, vanishing and exploding gradients. Architecture of Long Short-Term Memory (LSTM) Architecture of Gated Recurrent Units (GRU)	9

4	(Detailed mathematical treatment not required for this module) Introduction to Generative Models GANs - adversarial training. Discriminator, Generator. Introduction to Transformer models – architecture, word embedding, position encoding, attention, basics of training transformer models. Basics of Large language model - GPT	9
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Internal Ex</i>	<i>Evaluate</i>	<i>Analyse</i>	<i>Total</i>
5	15	10	10	40

Criteria for Evaluation (Evaluate and Analyse): 20 marks

Evaluation Methods:

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

Students will perform specific experiments using tools like TensorFlow, PyTorch, or Keras. Each experiment will focus on implementing and analyzing different types of neural network architectures and techniques.

2: Course Project (10 marks)

Comprehensive project involving design, implementation, and analysis of neural network models. Project phases: Proposal, Design, Implementation, Testing, Final Report, Presentation, and Viva Voce.

Sample Experiments:

Experiment 1: Building a Convolutional Neural Network (CNN)

- **Objective:** Design and train a CNN for image classification.
- **Tools:** TensorFlow/Keras or PyTorch.
- **Steps:**
 - Implement a CNN with convolutional layers, pooling layers, and fully connected layers.
 - Train the model on a dataset like CIFAR-10.
 - Analyze the model's performance using evaluation metrics like accuracy and loss curves.

Experiment 2: Visualizing Feature Maps and Weight Distributions

- **Objective:** Visualize the internal workings of a neural network.

- **Tools:** TensorFlow/Keras or PyTorch, Matplotlib.
- **Steps:**
 - Train a CNN on a simple dataset.
 - Visualize the feature maps after each convolutional layer.
 - Use t-SNE for feature visualization and analyze the distribution of weights.

Experiment 3: Transfer Learning and Fine-Tuning

- **Objective:** Use a pre-trained model for a new task.
- **Tools:** TensorFlow/Keras or PyTorch.
- **Steps:**
 - Use a pre-trained model like VGG or ResNet.
 - Fine-tune the model on a new dataset.
 - Analyze the performance improvement compared to training from scratch.

Experiment 4: Exploring Recurrent Neural Networks

- **Objective:** Implement an RNN to predict time-series data(eg. Word prediction).
- **Tools:** TensorFlow/Keras or PyTorch.
- **Steps:**
 - Build an RNN model with LSTM or GRU cells..
 - Train the model on a time-series dataset
 - Visualize and interpret the model's predictions.

Sample Project Topics:

- 1 Designing a Real-Time Object Detection System Using YOLO
- 2 Development of a Neural Network for Sentiment Analysis on Social Media
- 3 Implementing a GAN for Image-to-Image Translation
- 4 Building a Speech Recognition System Using RNNs and LSTMs
- 5 Creating a Transfer Learning Model for Medical Image Classification

Criteria for Evaluation: Lab Experiments (10 marks)

Understanding of Concepts (3 marks)

- Demonstrates a thorough understanding of the theoretical concepts related to the experiments.
- Correctly explains the purpose and expected outcomes.

Implementation and Accuracy (3 marks)

- Correctly implements the neural network models using appropriate tools.
- Ensures the design functions as expected with minimal errors.

Analysis and Problem-Solving (2 marks)

- Effectively analyzes the model performance and identifies issues.
- Demonstrates problem-solving skills in addressing challenges encountered during experiments.

Documentation and Reporting (1 mark)

- Provides detailed documentation of the experimental setup, process, and outcomes.
- Includes visualizations, code snippets, and analysis of results.

Presentation and Communication (1 mark)

- Clearly presents the experiments and their results.
- Able to answer questions and explain design choices.

Course Project (10 marks)

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.

Design and Implementation (3 marks)

- Implements the project design accurately using appropriate tools and techniques.
- The design is functional and meets the project objectives.

Innovation and Creativity (2 marks)

- Introduces innovative ideas or unique approaches in the design and implementation.
- Demonstrates creativity in solving problems or optimizing designs.

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 model.

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 =24marks)	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	Illustrate the basic concepts of neural networks	K2
CO2	Train CNN models and Solve real world problems	K6
CO3	Create solutions for real world problems using Sequence models	K6
CO4	Understand the concepts of GAN	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		3							3
CO2	3	3	3	2	3							3
CO3	3	3	3	2	3							3
CO4	3	3	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	Learning Deep Learning	Magnus Ekman	Addison -Wesley	2022
2	Hands-on Machine learning with Sc-kit Learn Keras and Tensorflow	Aurelien Geron	Oreilly	2 nd Edition 2019
3	Dive Deep into Machine Learning	Astan Zhang and Zachary and Alexander semola	Cambridge University Press	2019

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Deep Learning.	Ian Goodfellow. Yoshua Bengio and Aaron Courville.	MIT Press	2016.
2	Neural Networks and Deep Learning: A Textbook..	Charu C. Aggarwal.	Springer	. 2019
3	Generative Deep Learning	David Foster	OReilly	2022
4	Build a Large Language Model	Sebastian Raschka	Manning	2023
5	Deep Learning with Python second Edition	Francois chollet	Manning	2021

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://www.cse.iitm.ac.in/~miteshk/CS6910.html
2	https://cs231n.github.io/
3	https://wiki.pathmind.com/lstm http://colah.github.io/posts/2015-08-Understanding-LSTMs/
4	https://jalamar.github.io/illustrated-transformer/ Jay Almar

SEMESTER S8

MECHATRONICS

Course Code	PEAET895	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)	-	Course Type	Theory

Course Objectives:

1. To provide a deep understanding of mechatronics concepts, systems and its components.
2. To familiarize various actuation systems for mechatronics

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Mechatronics Definition and scope of Mechatronics, Key elements of a mechatronic system - sensors, actuators, controllers, and interfaces. Multi disciplinary nature of Mechatronics, Comparison between traditional design and mechatronics approach, applications of mechatronics in industry (robotics, automotive, aerospace, consumer electronics). Sensors (Basic working only) –Position, displacement, and proximity sensors (encoders, potentiometers, LVDTs, IR sensors), acoustic emission sensors, vibration sensors and tactile sensors, flow sensors.	9
2	Electrical Actuators and Control Systems Types of actuators (basics only) - Electromechanical, hydraulic, pneumatic, and piezoelectric. Overview of Relays and solenoids. Electric motors (working only) - DC, stepper, and servo motors Motor control techniques - PWM control, H-bridge circuits, motor drivers. Selection criteria for actuators and drive systems in mechatronic design. Overview of Proportional, Integral, and Derivative (PID) control, Example practical implementation of control algorithms on mechatronic systems	9

3	Actuation Systems Hydraulic and Pneumatic actuation systems (basics only) - Introduction, reciprocating cylinders, Rotary actuators – gear, vane and lobe. Comparison between electrical, pneumatic and hydraulic actuators. Mechanical power transmission systems –spur gears, bevel gear, planetary gear, Belts and chains. Direction control valve, pressure control valves, solenoid valve.	9
4	Mechatronic Design and Modern Trends Design considerations for mechatronic systems (cost, reliability, scalability). Case studies (Basic overview only) - Examples of mechatronic system (robotic arm, Robotic vision system, autonomous vehicle, Auto focus camera, automatic car park barrier system, Assembly line automation in manufacturing). Introduction to smart sensors and actuators, Basics of Mechatronics in Industry 4.0, Overview of Soft robotics and human-machine interfaces	9

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

Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Internal Ex</i>	<i>Evaluate</i>	<i>Analyse</i>	<i>Total</i>
5	15	10	10	40

Criteria for Evaluation (Evaluate and Analyze): 20 marks

- Each student should Design and hardware/software implementation of a project involving electronic control of mechanical parts.
- Computational tools such as MATLAB or Octave can be utilized for simulation and analysis.

Evaluation Parameters

Project Proposal and Planning

- Submits a well-defined project proposal outlining objectives, methodology, and expected outcomes.
- Demonstrates thorough planning and a clear timeline for the project.

Design and Implementation

- Implements the project design accurately using appropriate tools and techniques.
- The design is functional and meets the project objectives.

Innovation and Creativity

- Introduces innovative ideas or unique approaches in the design and implementation.
- Demonstrates creativity in solving problems or optimizing designs.

Analysis and Testing

- Effectively analyzes the project design to identify and address any issues.
- Conducts thorough testing to verify the functionality and performance of the model.

Final Report and Presentation

- 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.

Sample project topics:

1. Robotic Arm
2. Automated Sorting System
3. Self-Balancing Robot
4. Inverted Pendulum with 2 DOF

The project deliverables consist of the following components:

- Detailed design specifications
- Identification and resolution of technical challenges
- Designed and developed algorithms
- Implementation results and performance evaluations
- Comprehensive project report, incorporating methodology, results, challenges, and recommendations.

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 mechatronics systems and its components	K2
CO2	Familiarise sensors and electrical actuators for mechatronics	K2
CO3	Apply concepts hydraulic, pneumatic and mechanical actuation systems for designing mechatronic equipments	K4
CO4	Design mechatronic systems for various applications	K6

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	3		2							3
CO2	3	2	3		2							3
CO3	3	2	3		2							3
CO4	3	2	3		2				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	Fundamentals of Mechatronics	Musa Jouaneh	Cengage Learning	1 st Edition, 2013
2	Mechatronics: A multidisciplinary approach	William Bolton	Pearson	4 th Edition, 2014
3	Introduction to Mechatronics and Measurement Systems	David G. Alciatore and Michael B. Hstand	McGraw Hill	4 th Edition, 2012

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering	William Bolton	Pearson	6 th Edition, 2019
2	Mechatronics: Principles and Applications	Godfrey Onwubolu	Elsevier	1 st Edition, 2005
3	Mechatronics: Integrated Mechanical Electronic Systems	K.P. Ramachandran, G.K. Vijayaraghavan and M.S.Balasundaram	Wiley	1 st Edition, 2008
4	Mechatronics	Dan Neculescu	Pearson	1 st Edition, 2002
5	Mechatronics : Principles, Concepts and Applications	Nitaigour Premchand Mahalik	McGraw Hill	1 st Edition, 2012

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/107/112107298/
2	https://archive.nptel.ac.in/courses/112/107/112107298/
3	https://archive.nptel.ac.in/courses/112/107/112107298/
4	https://archive.nptel.ac.in/courses/112/107/112107298/

SEMESTER S8

INTRODUCTION TO MECHATRONICS

Course Code	OEAET831	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)	-	Course Type	Theory

Course Objectives:

1. To provide a deep understanding of mechatronics concepts, systems and its components.
2. To familiarize various actuation systems for mechatronics

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Mechatronics Definition and scope of Mechatronics, Key elements of a mechatronic system - sensors, actuators, controllers, and interfaces. Multi disciplinary nature of Mechatronics, Comparison between traditional design and mechatronics approach, applications of mechatronics in industry (robotics, automotive, aerospace, consumer electronics). Sensors (Basic working only) –Position, displacement, and proximity sensors (encoders, potentiometers, LVDTs, IR sensors), acoustic emission sensors, vibration sensors and tactile sensors, flow sensors.	9
2	Electrical Actuators and Control Systems Types of actuators (basics only) - Electromechanical, hydraulic, pneumatic, and piezoelectric. Overview of Relays and solenoids. Electric motors (working only) - DC, stepper, and servo motors Motor control techniques - PWM control, H-bridge circuits, motor drivers. Selection criteria for actuators and drive systems in mechatronic design. Overview of Proportional, Integral, and Derivative (PID) control, Example	9

	practical implementation of control algorithms on mechatronic systems	
3	Actuation Systems Hydraulic and Pneumatic actuation systems (basics only) - Introduction, reciprocating cylinders, Rotary actuators – gear, vane and lobe. Comparison between electrical, pneumatic and hydraulic actuators. Mechanical power transmission systems –spur gears, bevel gear, planetary gear, Belts and chains. Direction control valve, pressure control valves, solenoid valve.	9
4	Mechatronic Design and Modern Trends Design considerations for mechatronic systems (cost, reliability, scalability). Case studies (Basic overview only) - Examples of mechatronic system (robotic arm, Robotic vision system, autonomous vehicle, Auto focus camera, automatic car park barrier system, Assembly line automation in manufacturing). Introduction to smart sensors and actuators, Basics of Mechatronics in Industry 4.0, Overview of Soft robotics and human-machine interfaces	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 mechatronics systems and its components	K2
CO2	Familiarise sensors and electrical actuators for mechatronics	K2
CO3	Apply concepts hydraulic, pneumatic and mechanical actuation systems for designing mechatronic equipments	K4
CO4	Design mechatronic systems for various applications	K4

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	3		2							3
CO2	3	2	3		2							3
CO3	3	2	3		2							3
CO4	3	2	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	Fundamentals of Mechatronics	Musa Jouaneh	Cengage Learning	1 st Edition, 2013
2	Mechatronics: A multidisciplinary approach	William Bolton	Pearson	4 th Edition, 2014
3	Introduction to Mechatronics and Measurement Systems	David G. Alciatore and Michael B. Hstand	McGraw Hill	4 th Edition, 2012

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering	William Bolton	Pearson	6 th Edition, 2019
2	Mechatronics: Principles and Applications	Godfrey Onwubolu	Elsevier	1 st Edition, 2005
3	Mechatronics: Integrated Mechanical Electronic Systems	K.P. Ramachandran, G.K. Vijayaraghavan and M.S.Balasundaram	Wiley	1 st Edition, 2008
4	Mechatronics	Dan Neculescu	Pearson	1 st Edition, 2002
5	Mechatronics : Principles, Concepts and Applications	Nitaigour Premchand Mahalik	McGraw Hill	1 st Edition, 2012

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/107/112107298/
2	https://archive.nptel.ac.in/courses/112/107/112107298/
3	https://archive.nptel.ac.in/courses/112/107/112107298/
4	https://archive.nptel.ac.in/courses/112/107/112107298/

SEMESTER S8

INDUSTRY 4.0

Course Code	OEAET832	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)	-	Course Type	Theory

Course Objectives:

1. To familiarize Industrial IoT and Industry 4.0
2. To understand various enabling technologies and trends in Industry 4.0

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Industry 4.0 Overview and evolution of Industry 4.0, Key aspects and components of Industry 4.0. Industrial IoT (IIoT) – Introduction, IIoT reference architecture, overview of three tier topology of IIoT (edge tier, platform tier and enterprise tier) Basics of cyber physical systems (CPS), CPS and IIoT, Applications of IIoT Industrial Internet Systems (IIS) – Fundamentals, elements of IIS (analytics, intelligent machines and connected people). Applications of Industry 4.0.	9
2	Enabling Technologies in Industry 4.0. Smart factories – Introduction, characteristics of smart factories, benefits, smart factories versus traditional factories. Industrial sensing – Smart sensors, enhanced sensors (virtual sensors, self-calibration, self-testing, self-learning), introduction to tool condition monitoring.	10

	Introduction to customized and modular robotic systems (basics only), Additive Manufacturing (AM) - Introduction, The general AM process chain, advantages and limitations of AM. Advantages of 3D printing technology for Industry 4.0	
3	Big Data and AI in Industry 4.0 Big Data – Introduction, characteristics of big data, big data sources, big data acquisition and storage, necessity of big data analytics (basics only). Machine learning and artificial intelligence for industry 4.0 (overview only), applications of ML in industries. Blockchain for Industry 4.0 – Introduction, challenges for blockchain implementation.	9
4	Recent Trends Data Security (basics only) – types of cyber security threats, Need for security in IIoT (software security, network security, mobile device security) Introduction to Cloud Computing for Industry 4.0 (Overview and advantages only). Introduction to Smart supply chain management - Advantages of IIoT in inventory management. Introduction to Industry 5.0. Case study (application and benefits of IIoT only) – Manufacturing industry and Automotive industry.	8

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	Illustrate the fundamentals of Industrial IoT and Industry 4.0	K2
CO2	Understand the enabling technologies for Industry 4.0	K2
CO3	Apply machine learning and big data for Industry 4.0	K3
CO4	Explain the cloud computing and security issues.	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	3		3							3
CO2	3	2	3		3							3
CO3	3	2	3		3							3
CO4	3	2	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	Industry 4.0: Concepts, Processes and Systems	Ravi Kant and Hema Gurung	CRC Press	1 st Edition, 2024
2	Introduction to Industrial Internet of Things and Industry 4.0	Sudip Misra, Chandana Roy, Anadarup Mukherjee	CRC Press	1 st Edition, 2021
3	Industry 4.0: The Industrial Internet of Things	Alasdair Gilchrist	APress	1 st Edition, 2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Industrial IoT Application Architecture and Use Cases	Suresh, Malarvizhi Nandagopal, Pethuru Raj, E. A. Neeba, Jenn Wei Lin	CRC Press	1 st Edition, 2020
2	Hands On Industrial Internet of Things	Giacomo Veneri and Antonio Capasso	Packt	1 st Edition, 2018
3	Industrial Internet of Things: Technologies and Research Directions	Anand Sharma, Sunil Kumar Jangir, Manish Kumar, Dilip Kumar Choubey, Tarun Shrivastava, S. Balamurugan	CRC Press	1 st Edition, 2022
4	5G-Enabled Industrial IoT Networks	Amitava Ghosh, Rapeepat Ratasuk, Peter Rost, Simone Redana	Artech House	1 st Edition, 2022
5	IoT Product Design and Development: Best Practices for Industrial, Consumer, and Business Applications	Ahmad Fattahi	Wiley	1 st Edition, 2023
6	Industrial Internet of Things (IIoT): Intelligent Analytics for Predictive Maintenance	R. Anandan, S. Gopalakrishnan, Souvik Pal and Noor Zaman	Wiley	1 st Edition, 2022
7	Technology for People: Industry 5.0 = Industry 4.0 + Society 5.0	Mune Moğol Sever	Literaturk Academia	1 st Edition, 2024

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/106105195
2	https://nptel.ac.in/courses/106105195
3	https://nptel.ac.in/courses/106105195
4	https://nptel.ac.in/courses/106105195

SEMESTER S8

VIRTUAL INSTRUMENTATION

Course Code	OEAET833	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)	-	Course Type	Theory

Course Objectives:

1. To understand the architecture and components of a virtual instrument.
2. To design simple virtual instruments.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Virtual Instrumentation Introduction and definition of Virtual Instrumentation (VI), block diagram and architecture of a virtual instrument, Virtual instruments versus traditional instruments, advantages of VI. Overview of Virtual Instrumentation in the Engineering Process – Design, Test and Control, Virtual Instruments Beyond the Personal Computer. Overview of graphical programming for VI. Software tools used in VI (Features and advantages only) – LabView, MATLAB/Scilab, Python Introduction to Smart Instruments (Basic concepts only)	9
2	Introduction to LabVIEW Introduction to Graphical system design using LabVIEW, Advantages of LabVIEW, Key elements in LabVIEW(Overview only) - Front Panel and Block Diagram. Concept of Virtual Instruments (VIs) and SubVIs, Steps involved in Developing Virtual Instruments using LabVIEW, Real time data acquisition - analog and digital Input/Output operations in LabVIEW, Basic concept of clusters in LabVIEW, Simple design examples using LabVIEW	9

	(Data Logging, Monitoring, Control Systems), Introduction to LabVIEW Realtime, LabVIEW FPGA and LabVIEW Embedded.	
3	Data Acquisition Systems (DAQ) Introduction to data acquisition on PC, Components of a Data Acquisition System, Analog vs. Digital signals, Sampling fundamentals and sampling theorem, Basics of ADC and DAC, Overview and need of Signal Conditioning (Amplification and Filtering), Interfacing sensors with data acquisition systems, Calibration, Resolution, Data acquisition interface requirements.	9
4	Common Instrument Interfaces Overview of Instrument control using VISA (Virtual Instrument Software Architecture), Basics of 4-20mA current loop. Serial versus parallel data transfer, concept of baud rate, overview of RS-232. GPIB – Introduction, types of messages, overview of physical bus structure, advantages, Overview of IEEE 488.2, Basics of Standard Commands for Programmable Instruments (SCPI). USB – Introduction, need for USB, overview of USB data format, advantages. Overview of MOD Bus.	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 architecture and components of a virtual instrument.	K2
CO2	Design simple virtual instruments.	K6
CO3	Familiarize data acquisition techniques to design virtual instruments	K3
CO4	Illustrate various instrument interface protocols	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	3		3							3
CO2	3	2	3		3							3
CO3	3	2	3		3							3
CO4	3	2	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	Virtual Instrumentation Using Labview	Jovitha Jerome	Prentice Hall	1 st Edition, 2010
2	Labview Based Advanced Instrumentation	S Sumathi, P. Surekha	Springer	1 st Edition, 2007

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Learning with LabVIEW	Robert Bishop	Pearson	2 nd Edition, 2020
2	Real World Instrumentation with Python	J. M. Hughes	O'Reilly	1 st Edition, 2010
3	LabVIEW for Everyone: Graphical Programming Made Easy and Fun	Jeffrey Travis and Jim Kring	Prentice Hall	3 rd Edition, 2006
4	LabVIEW Graphical Programming	Gary W. Jhonson and Richard Jennings	McGraw Hill	4 th Edition, 2006
5	PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control	Kevin James	Newnes	1 st Edition, 2000
6	Virtual Instrumentation Using LabVIEW	Sanjay Gupta and Joseph John	McGraw Hill	2 nd Edition, 2010

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://youtu.be/ZHNIKyYzrPE?si=Q0XfJfrI_mKsVEI-
2	https://youtu.be/ZHNIKyYzrPE?si=Q0XfJfrI_mKsVEI-
3	https://nptel.ac.in/courses/108105062
4	https://nptel.ac.in/courses/108105062