SEMESTER 5

ELECTRICAL AND COMPUTER ENGINEERING

SEMESTER S5

MICROCONTROLLERS AND EMBEDDED SYSTEMS

Course Code	**PCEOT501**	**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)	NIL	**Course Type**	Theory

Course Objectives:

1. Provide a solid foundation in the principles, programming, and applications of the 8051 micro controller
2. Develop expertise in the architecture and programming of ARM processors

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Microprocessors and Microcontrollers**-comparison of microprocessors and microcontrollers-Introduction to Embedded Systems-Application domain of embedded systems, features and characteristics, hard and soft real time systems **8051-Microcontrollers Hardware:** Microcontroller Architecture: IO Port structure, Register organization, general purpose RAM, Bit Addressable RAM, Special Function Registers (SFRs).	**9**
2	**Assembly programming of 8051:** Introduction to8051 assembly programming, Data types and Assembler directives, 8051 Addressing Modes, simple Assembly language programs(data transfer and arithmetic operations only) **8051 programming in C:** Data types and time delay in 8051, I/O	**11**

	programming in 8051 **8051 Timer/Counter programming in embedded C:** Programming 8051 timers, Counter programming,	
3	**8051 serial port programming in embedded C:** Basics of serial communication, 8051 connections to RS232, serial port programming in 8051. **8051 Interrupt programming in embedded C:** 8051 interrupts, external hardware and serial communication interrupt, Interrupt priority in 8051, Interrupt programming in C. **Interfacing:** LCD, ADC & DAC. Motor control: Relays and, stepper motor interfacing, DC motor interfacing and PWM using 8051	**12**
4	**Introduction to ARM processors** –ARM core-ARM Microcontroller-RISC vs CISC-Advanced features of ARM-Architecture versions-ARM Architecture-Instruction set architecture, operating modes, register set, General purpose registers- mode switching, conditional flags, Simple ALP programs on Arithmetic & logical operation, addition, subtraction, multiplication, division and factorial.	**12**

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 general characteristics of embedded system and distinguish hard and soft real time systems	**K2**
CO2	Explain the architecture of a 8051 microcontroller	**K2**
CO3	Develop assembly language and Embedded C program for 8051 microcontroller**.**	**K3**
CO4	Develop assembly language for interfacing of different peripheral devices with 8051	**K3**
CO5	Explain the architecture of an ARM processor	**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**											
CO2	**3**	**2**										
CO3	**3**	**2**	**3**	**2**	**2**	**2**						**1**
CO4	**3**	**2**	**2**	**2**	**2**							
CO5	**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	The 8051 Microcontroller and Embedded Systems using assembly and C	Muhammad Ali Maidu and Janice Gillespie	Pearson	2nd Edition, 2007
2	Embedded Systems: An Integrated Approach,	Lyla B Das	Pearson Education	2013
3	The 8051 Microcontroller	Kenneth J. Ayala	Thomson /Cengage Learning	3rd Edition,2007
4	Microcontroller: Architecture Assembly	Craig Steiner	Publisher: WP Publishers / Microsoft Press	
5	ARM system-on-chip architecture	Steve Furber	Addison Wesley	

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	The 8051 Microcontroller Based Embedded Systems	Manish K Patel	McGraw Hill	July 2017
2	Microcontrollers: Architecture, Programming, Interfacing and System Design	Raj Kamal	Pearson Education	January 2011
3	The 8051 microcontrollers, architecture and programming and applications	K Uma Rao & Andhe Pallavi	Pearson	January 2010

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/108105102
2	https://nptel.ac.in/courses/108105102
3	https://nptel.ac.in/courses/108105102
4	https://nptel.ac.in/courses/108105102

SEMESTER S5

POWER ELECTRONICS

Course Code	PCEOT502	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)	PCEOT205, PCEOT402	Course Type	Theory

Course Objectives:

1. To give a strong foundation on power converters, power quality and electric drives
2. To enable the students to select suitable power devices and passive components for target applications
3. To motivate students to design and implement power electronic converters having high efficiency,
   small size, high reliability and low cost

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Role of Power Electronics, Motivation, Objectives and Challenges, Power Electronics Vs Linear Electronics, Ideal and real switches- Static and dynamic Performance – Power losses- Temperature rise- Thermal Analogy- Use of Heat sinks- Need for high efficiency, small size, high reliability and low cost- Overview of Applications [2 Hrs] Uncontrolled Switch: Power Diodes – Types- Characteristics (Static and Dynamic) – Effects of Reverse Recovery Transient- Ratings- Schottky Diodes-Features & Applications [2 Hrs] Semi-controlled switch: SCR (Thyristor) – Symbol, Structure, Characteristics (Static and dynamic) – Turn-on and Turn-off phenomena –	11

	Ratings- Gate control of SCR – Gate pulse magnitude and duration requirements- Typical gate drive circuits – Gate synchronisation – Isolated gate drives [3 Hrs] Fully-controlled switches: MOSFETS and IGBTs: Symbol, Structure, Characteristics (Static and dynamic) - Device ratings- Gate drive requirements– Typical gate drive circuits [3 Hrs] Modern power devices: Introduction to Wide Bandgap Devices – SiC MOSFET and GaN HEMT – Features and advantages [1 Hr] 4. Power Electronics- Essentials and Applications by L. Umanand, John Wiley, 2009	
2	Controlled Rectifiers (Single Phase) – Fully controlled and half-controlled rectifiers (semi-converter) with RL and RLE loads- Rectifier and inverter modes of operation- waveforms (continuous & discontinuous conduction)– Output voltage, Input line current, Real Power, Power factor and THD (Continuous conduction, ripple free current) - Effect of source inductance (Full converter in continuous conduction, ripple free current) [5 Hrs] Controlled Rectifiers (3-Phase) - Fully controlled & Half-controlled bridge converter with RLE load (continuous conduction, ripple free current)– Waveforms- Output voltage equation [3 Hrs] DC-DC Switching Regulators- Buck, Boost & Buck-Boost– Operation with Continuous conduction Waveforms– Effect of non-idealities such as capacitor ESR and inductor resistance (qualitative treatment only)- Design of filter inductance and capacitance- Selection of power devices [4 Hrs]	**12**
3	AC voltage controllers (ACVC) – 1-phase full-wave ACVC with R & RL loads – waveforms – RMS output voltage - applications [1 Hr] Switch mode DC-AC Voltage Source Inverters (VSI)- Single phase Half-Bridge and Full-Bridge configurations- Sinusoidal Pulse Width Modulation (PWM) - Control of Fundamental output voltage- Harmonic spectrum- Bipolar and Unipolar PWM- Linear, Over Modulation and Square wave modes -Merits and demerits- Need for blanking time (dead-time) [4 Hrs] Three-Phase Pulse Width Modulated VSI - Fundamental Output voltage- Linear, Over Modulation and Square wave modes – Third harmonic Injection PWM [3 Hrs] Single phase IGBT based current source Inverter(CSI)- Comparison	**10**

	between VSI and CSI [1 Hr] Need for improved utility interface- Generation of current harmonics- Power factor- Harmonics and IEEE 519 standard- Active shaping of the input line current [1 Hr]	
4	Introduction to Electric Drives– Advantages of adjustable speed electric drives – Block diagram, Types of loads – Classification of load torque- Motor torque-load combination: characteristics and dynamic equation- Steady state stability [3 Hrs] DC Drives- Chopper control of Separately Excited DC drives (SEDC) –One quadrant, Two quadrant and four quadrant Chopper fed drives (Continuous conduction only)- Motoring and Regenerative braking – Speed-Torque characteristics – Speed control- Controlled rectifier fed separately excited DC motor drive- Single phase and three phase (Continuous conduction only)- Speed-Torque characteristics- Speed control – Dual converter drives (single phase) - Circulating current Type and Non-circulating current - Static four-quadrant operation with SEDC [5Hrs] Three-phase VSI fed induction motor drives: Stator Voltage control - V/F speed control– Speed-Torque characteristics- Speed control – operation below and above base speed – Braking: dynamic and regenerative [3 Hrs]	**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 the operation of modern power semiconductor devices, its characteristics and Select suitable gate driver circuits & heatsinks	**K5**
CO2	Understand the features of phase-controlled rectifiers, AC voltage Controllers & Switching Regulators and Analyse the operation	**K4**
CO3	Understand the features of different types of switch mode DC-AC Inverters and Analyse the operation	**K3**
CO4	Understand the need for improved efficiency, improved reliability, improved load & source waveforms and improved utility interface	**K3**
CO5	Understand the features of adjustable speed drives and Analyse the basic drive schemes for DC motors and Induction Motors	**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	3									
CO2	3	1	3									
CO3	3	1	3									
CO4	3	1	3									
CO5	3	1	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- Converters, Applications and Design, 3ed(Indian Adaptation) by Mohan, Undeland, Robbins, Wiley India, 2022	Ned Mohan, Undeland, Robbins	Wiley-India	2022
2	Power Electronics- Principles and Applications	Joseph Vithayathil	Tata Mcgraw Hill	2010
3	Power Electronics	Cyril W Lander	McGrawHill	1993
4	Power Electronics – Circuits, Devices and Applications	Muhammad H. Rashid	Pearson Education	2014
5	Power Electronics	D.W. Hart	McGrawHill	2010
6	Power Electronics – Essentials & Applications	L. Umanand	Wiley-India	2009
7	Fundamentals of Electric Drives	G K Dubey	Narosa	2001

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Elements of Power Electronics	Philip T Krein	Oxford	2017
2	Power Electronics Handbook-5e	Muhammad H. Rashid	Butterworth	2024

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	Lecture Series on Power Electronics by Prof. G. Bhuvaneswari, IIT Delhi https://www.youtube.com/watch?v=Z2CORFayCv0&list=PLp6ek2hDcoND7i5-DAD9mPmYF1Wg6ROdO&index=3
2	NPTEL Lecture Series on Power Electronics by Prof. L. Umanand, IISc Bangalore https://www.youtube.com/watch?v=eLIdqiPMjBs&list=PLgMDNELGJ1CaXa4sX6QSrkhu-yP_Wu2EN&index=26
3	NPTEL Lecture Series by Prof. Shabari Nath, IIT Guwahati https://www.youtube.com/watch?v=S_UXW2UzAi8&list=PLwdnzlV3ogoWVgA9fHBV36L_bxWZlpa7X&index=7

SEMESTER S5

POWER SYSTEMS

Course Code	**PCEOT503**	**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)	GYEST104	**Course Type**	Theory

Course Objectives:

1. To deliver fundamental concepts in power system components.
2. To deliver basic idea of power generation, transmission and protection.
3. To deliver fundamental concepts of protection in power system.
4. To deliver fundamental concepts of steady state and transient analysis in power system.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Generation from renewable and non-renewable sources – Hydro, thermal, nuclear- (block schematic details, environmental and ethical factors, advantages, disadvantages) Solar and wind - (block schematic details, environmental factors, regulations, advantages, disadvantages) Energy storage systems as alternative energy sources – BESS, CESS, thermal SS Load curve – Load duration curve, Load factor, diversity factor, demand factor, Plant capacity factor, plant use factor - Numerical Problems.	**11**
2	Power Transmission System - (Electrical Model) - Line parameters – resistance - inductance and capacitance (Derivation of three phase double circuit) Transmission line modelling - classifications (concept only) – transmission	**11**

	line as two port network – derivation and calculation of ABCD parameters (derivation and numerical problems) Skin Effect & Ferranti Effect – Corona (qualitative study only) – Surge Impedance Loading Insulators – string efficiency – grading (numerical problems)	
3	Per unit quantities-single phase and three phase Symmetrical components - sequence networks Types of faults – Fault calculations(shunt only)-symmetrical and unsymmetrical Need for protection- Types of protection schemes – primary and back-up Protective relays – Basics of typical electromechanical relay – induction type only - Static (block diagrams of over current and instantaneous over current relays) Microprocessor (block diagram and flow chart of overcurrent relay) – Fundamentals of Numerical relay Principles of overcurrent, directional, distance and differential Circuit breakers – operating principle – arc phenomenon – arc extinction – principle & methods Circuit breaker classification based on medium of arc extinction – SF6 & VCB	**11**
4	Load flow studies – Introduction- Types of buses - Network model - admittance matrix- Gauss Siedal method of load flow analysis (Qualitative analysis)– (numerical problems not required) Power system stability - steady state, dynamic and transient stability power angle curve - steady state stability limit - swing equation Equal area criterion and application - methods of improving stability limits	**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	Learn different types of power generating systems and schedule generation appropriate for a given area.	**K2**
CO2	Understand the electrical performance of any transmission line.	**K2**
CO3	Demonstrate the working of switchgear for protection schemes.	**K2**
CO4	Analyse the voltage profile of any given power system network using iterative methods.	**K3**
CO5	Analyse the steady state and transient stability of power system networks.	**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**	**2**			**1**	**1**
CO2	**3**	**3**										**1**
CO3	**3**	**1**				**2**		**2**				**1**
CO4	**3**	**3**	**2**		**1**							**1**
CO5	**3**	**3**	**2**		**1**							**1**

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	Electrical Power Systems	Wadhwa C. L.	New Age International	8th edition 2023
2	Principles of Power System	V. K. Mehta and Rohit Mehta	S.Chand	4th edition reprint 2020
3	Power System Protection and Switchgear	Badri Ram and D. N. Viswakarma	Tata McGraw Hill	2nd edition, 2011
4	Non-conventional energy sources	B. H. Khan	Tata McGraw Hill	3rd edition, 2017
5	Power System Analysis	Hadi Saadat	McGraw Hill	2nd edition, 2002.
6	Modern Power System Analysis	D. P. Kothari and I. J. Nagrath	McGraw Hill	2nd edition, 2002.
7	Power System Analysis and Design	Gupta B. R.,	S. Chand	2006

SEMESTER S5

DATABASE MANAGEMENT SYSTEM

Course Code	PBEOT504	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)	None	Course Type	Theory

Course Objectives:

1. Understand the Fundamentals of Database Systems
2. Develop Proficiency in ER Modelling and Relational Databases
3. Master SQL for Database Manipulation and Querying
4. Identify and address anomalies in relational database design through normalization
5. Comprehend the principles of transaction processing
6. Explore the characteristics and applications of NoSQL databases

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Concept & Overview of Database Management Systems (DBMS) - Characteristics of Database system, Structured, semi-structured and unstructured data. Data Models and Schema - Three Schema architecture. Database Languages. ER model - Basic concepts, entity set & attributes, notations, Relationships and constraints, cardinality, participation, notations, weak entities, relationships of degree 3. Physical Data Organization - Review of terms: physical and logical records, blocking factor, pinned and unpinned organization. Heap files, Indexing, Singe level indices, numerical examples, Multi-level-indices, numerical examples	9

2	Structure of Relational Databases - Integrity Constraints, Synthesizing ER diagram to relational schema Structured Query Language (SQL), Data Definition Language (DDL), Table definitions and operations – CREATE, DROP, ALTER, INSERT, DELETE, UPDATE.SQL DML (Data Manipulation Language) - SQL queries on single and multiple tables, Nested queries (correlated and non-correlated), Aggregation and grouping, Views, assertions, Triggers, SQL data types, Recursive queries, Accessing SQL from a Programming Language	**9**
3	Different anomalies in designing a database, The idea of normalization, Functional dependency, Armstrong's Axioms (proofs not required), Closures and their computation, Equivalence of Functional Dependencies (FD), Minimal Cover (proofs not required). First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF), Boyce Codd Normal Form (BCNF), Lossless join and dependency preserving decomposition, Algorithms for checking Lossless Join (LJ) and Dependency Preserving (DP) properties	**9**
4	Transaction Processing Concepts - overview of concurrency control, Transaction Model, Significance of concurrency Control & Recovery, Transaction States, System Log, Desirable Properties of transactions. Serial schedules, Concurrent and Serializable Schedules, Conflict equivalence and conflict serializability, Recoverable and cascade-less schedules, Locking, Two-phase locking, and its variations. Log-based recovery, Deferred database modification, check-pointing. Introduction to NoSQL Databases, Main characteristics of Key-value DB (examples from Redis), Document DB (examples from MongoDB) Main characteristics of Column-Family DB (examples from Cassandra), and Graph DB (examples from ArangoDB)	**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	Summarize the characteristics of database systems and explain the purpose of a database index	**K2**
CO2	Model a database based on any mini-world description, using an ER diagram and map it to a relational database schema	**K3**
CO3	Frame SQL queries for relational database implementation, data organization, manipulation, and retrieval requirements	**K3**
CO4	Normalize a relational schema to an appropriate normal form and analyze the decomposition for quality	**K3**
CO5	Compare the different methods for concurrency control and recovery in databases, and Identify the applications of NoSQL databases	**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**
CO2	**3**	**3**	**3**	**2**					**2**		**2**	**2**
CO3	**3**	**3**	**3**						**2**		**2**	**2**
CO4	**3**	**3**	**3**	**3**					**2**		**2**	**2**
CO5	**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	Fundamentals of Database Systems	Elmasri, Navathe	Pearson	7th Edition, 2017
2	Database System Concepts	Silberschatz, Korth, Sudarshan	Mc Graw Hill	7th Edition, 2020

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	NoSQL for Mere Mortals	Dan Sullivan	Addison Wesley	1st Edition, 2015
2	NoSQL for Dummies	Adam Fowler	Wiley (For Dummies)	1st Edition, 2015

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc22_cs91/preview
2	https://onlinecourses.nptel.ac.in/noc22_cs91/preview
3	https://onlinecourses.nptel.ac.in/noc22_cs91/preview
4	https://onlinecourses.nptel.ac.in/noc22_cs91/preview

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)

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

ENERGY STORAGE SYSTEMS

Course Code	PEEET521	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 introduce the importance and application of energy storage systems.
2. To familiarize with different energy storage technologies.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Need and role of energy storage systems in power system, General considerations, Energy and power balance in a storage unit, Mathematical model of storage system: modelling of power transformation system (PTS)-Central store (CS) and charge–discharge control system (CDCS), Econometric model of storage system. Thermal energy: General considerations -Storage media-Containment- Thermal energy storage in a power plant, Potential energy: Pumped hydro-Compressed Air.	9
2	Kinetic energy: Mechanical- Flywheel, Power to Gas: Hydrogen-Synthetic methane. Electro chemical energy: Batteries-Battery parameters: C-rating– SoC – DoD -Specific Energy- Specific power (numerical examples), Fuel cells, Electrostatic energy (Super Capacitors), Electromagnetic energy (Superconducting Magnetic Energy Storage), Comparative analysis, Environmental impacts of different technologies.	9
3	Types of renewable energy sources: Wave - Wind – Tidal – Hydroelectric - Solar thermal technologies and Photovoltaics, Storage	

	role in isolated power systems with renewable powersources, Storage role in an integrated power system with grid-connected renewablepowersources.	**9**
4	Smart grid, Smart micro grid, Smart house, Mobile storage system: Electric vehicles – Grid to Vehicle (G2V)-Vehicle to Grid (V2G), Management and control hierarchy of storage systems. Aggregating energy storage systems and distributed generation (Virtual Power Plant Energy Management with storage systems), Battery SCADA, Hybrid energy storage systems: configurations and applications.	**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 role of energy storage in power systems.	K3
CO2	Classify thermal, kinetic and potential energy storage systems and their applications.	K3
CO3	Compare electrochemical, electrostatic and electromagnetic storage technologies.	K3
CO4	Illustrate energy storage technology in renewable energy integration.	K2
CO5	Summarise energy storage technology applications for smart grids.	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**	**1**					**1**					
CO2	**3**	**1**					**1**					
CO3	**3**	**1**					**1**					
CO4	**3**	**1**					**1**					
CO5	**3**	**1**					**1**					

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	Energy Storage for Power Systems	A.G.Ter- Gazarian	The Institution of Engineering and Technology (IET) Publication, UK,	Second Edition, 2011
2	Energy Storage in Power Systems	Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt	Wiley Publication	2016.

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electricity Energy Storage Technology Options: A White Paper Primer on Applications, Costs, and Benefits	D. Rastler	Electric Power Research Institute (USA)	Technical Update, December 2010
2	The Role of Energy Storage with Renewable Electricity Generation	Paul Denholm, Erik Ela, Brendan Kirby and Michael Milligan	National Renewable Energy Laboratory (NREL)	January 2010
3	Electrical energy management of virtual power plants in distribution networks with renewable energy resources and energy storage systems	P. Nezamabadi and G. B. Gharehpetian	IEEE Power Distribution Conferenc	2011

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://www.youtube.com/watch?v=o6Afp-MI_tQ&list=PLLy_2iUCG87AjWoOk0A3y4hpGQVTdtl6G&index=12 (NPTEL lecture IIT Roorkee)
2	https://www.youtube.com/watch?v=yar51GJVqgg (NPTEL lecture IIT Guwahati)
3	https://www.youtube.com/watch?v=frWxC5KL8kE (NPTEL lecture IIT Guwahati)
4	https://www.youtube.com/watch?v=AZIS_MCw8Qc (NPTEL lecture IIT Kanpur)

SEMESTER S5

ELECTRIC VEHICLES

Course Code	PEEET522	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	2:1:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCEET303, PCEET304 PCEET403	Course Type	Theory

Course Objectives:

1. Familiarise the various characteristics of conventional vehicles and compare them with electric vehicles
2. Analyse the various drive train topologies for electric vehicles
3. Discuss the propulsion unit for electric vehicles
4. Analyse the various energy storage systems and energy management strategies
5. Selection of drive systems and study of various communication protocols for EV

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Conventional Vehicles**: Basics of vehicle performance, Vehicle power source characterization, Transmission characteristics (1hr). **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(2hr) **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, Numerical problems. (4 hrs) **Electric Drive-trains**: Basic concept of electric traction, Introduction to various electric drive-train topologies, Power flow control in electric drive-train topologies, Fuel efficiency analysis.(2 hrs)	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. (3hrs) **PMSM Drives**: Review of PMSM motor basics – Independent control of orthogonal flux and torque (concept only) - Field Oriented Control (FOC) – Sensored and sensorless control (block diagram only). (4hrs) **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. (2hrs)	**9**
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- static battery equivalent circuit model - series-parallel battery pack equivalent circuits.(3hrs) **Other storage topologies**: Fuel Cell based energy storage systems- Supercapacitors- Flywheel- Hybridization of different energy storage devices. (2 hrs) **Sizing considerations of battery** -Time and charge/discharge cycles - Lifetime – Beginning of life (BOL) - End of life (EOL) - DOD - Efficiency of Battery Pack - Determination of pack Voltage, range for EV - Determination of Cell/Pack Voltage for a Given Output\Input Power. Battery management system, Numerical problems.(4hrs)	**9**
4	**Overview of Electric Vehicle Battery Chargers**–Types of chargers-On-board chargers, Off- board chargers, Wireless charger. Electric Vehicle Supply Equipment (EVSE) - Grid to EVSE to On-board chargers to battery pack power flow block schematic diagrams – V2G concept(3hrs) Types of charging stations - AC Level 1 & 2, DC - Level 3 -Types of Connectors - CHAdeMO, CCS Type1 and 2, GB/T - PIN diagrams and differences (2hrs) **Autonomous Vehicles**: Levels of automation, significance, functional architecture-sensors, actuators, path planning & effects of automation in vehicles (2 hrs) **Vehicle Communication protocols** : Need & requirements - Functions of Control Pilot (CP) and Proximity Pilot (PP) pins, Communication Protocols - CAN, LIN, FLEXRAY (Basics only)- Power line communication (PLC) in EV (2 hrs)	**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	Study of chargers, charging stations and various communication protocols for EV	**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
CO3	3		2									3
CO4	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	Electric Vehicles Machines and Drives- Design, Analysis and Application	K. T. Chau	John Wiley	2015
2	Propulsion Systems for Hybrid Vehicles	John M. Miller	The Institution of Engineering and Technology, London, United Kingdom	2010
3	Hybrid Electric Vehicles – Principles and applications with practical perspectives	Chris Mi, M A Masrur, D W Gao	Wiley	2011

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Modern Electric, Hybrid and Fuel Cell Vehicles: Fundamentals, Theory and Design	Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay	CRC Press	
2	Permanent Magnet Synchronous and Brushless DC Motors Drives	R. Krishnan	CRC Press	
3	Electric and Hybrid Vehicles: Design Fundamentals	Iqbal Hussein	CRC Press	2003

SEMESTER S5

DIGITAL SYSTEM DESIGN

Course Code	PEEET523	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 acquire knowledge about Asynchronous and clocked Synchronous sequential circuit design.
2. To detect the faults and hazards in digital circuit design
3. To design and implement digital circuits using VHDL.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Clocked Synchronous Networks, Analysis of Clocked Synchronous Sequential Networks (CSSN), Modeling of CSSN, State assignment and reduction, Design of CSSN.	10
2	ASM Chart and its realization. Asynchronous Sequential Circuits, Analysis of Asynchronous Sequential Circuits (ASC), Flow table reduction, Races in ASC, State assignment problem and the transition table.	10
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	8

	asynchronous inputs. Faults: Fault table method – path sensitization method – Boolean difference method.	
4	VLSI Design flow: Design entry: Schematic, Data types and objects, different modelling styles in VHDL - Dataflow, Behavioural and Structural Modelling. VHDL constructs and codes for combinational and sequential circuits.	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	Analyze asynchronous and clocked synchronous sequential circuits	**K3**
CO2	Design hazard-free digital circuits	**K3**
CO3	Identify faults in digital circuits	**K3**
CO4	Apply VHDL programming in digital system design	**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	2	2	2								3
CO3	3	3	2		2							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	Digital Principles & Design	Donald G Givone	Tata McGraw Hill	1/e 2002
2	Digital Design with an introduction to HDL, VHDL and Verilog	M.Morris Mano and Michel.D.Ciletti	Pearson education	6/e, 2018
3	Digital Design	John F Wakerly	Pearson Education	4/e 2008
4	Digital Logic Applications and Design	John M Yarbrough	Cengage India	1/e 2006

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	Miron Abramovici, Melvin A. Breuer and Arthur D. Friedman	John Wiley & Sons Inc	
2	Logic Design Theory	N. N. Biswas	PHI	
3	Introduction to Digital Design Using Digilent FPGA Boards	Richard E. Haskell, Darrin M. Hanna	LBE Books- LLC	
4	Digital Circuits and Logic Design	Samuel C. Lee	PHI	
5	Digital System Design Using VHDL	R. Anand	Khanna Book Publishing Company	
6	Digital System Design using VHDL	Charles Roth	TMH	

SEMESTER S5

SOFTWARE ENGINEERING

Course Code	PEEET524	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. Provides fundamental knowledge in the Software Development Process which covers Software Development, and Project Management concepts.
2. Enables the learners to apply state of the art industry practices in Software development.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Software Engineering:** Introduction to Software Engineering - Professional software development, Software engineering ethics. Software process models - The waterfall model, Incremental development. Process activities - Software specification, Software design and implementation, Software validation, Software evolution. Coping with change - Prototyping, Incremental delivery, Boehm's Spiral Model. Agile software development - Agile methods, agile manifesto - values and principles. Agile development techniques, Agile Project Management. Case studies : An insulin pump control system. Mentcare - a patient information system for mental health care.	8
2	**Requirement Analysis and Design:** Functional and non-functional requirements, Requirements engineering processes. Requirements elicitation, Requirements validation, Requirements change, Traceability Matrix. Developing use cases, Software Requirements Specification Template, Personas, Scenarios, User stories, Feature identification. Design	10

	concepts - Design within the context of software engineering, Design Process, Design concepts, Design Model. Architectural Design - Software Architecture, Architectural Styles, Architectural considerations, Architectural Design Component level design - What is a component?, Designing Class-Based Components, Conducting Component level design, Component level design for web-apps.	
3	**Implementation and Testing (12 hours)** Object-oriented design using the UML, Design patterns, Implementation issues, Open-source development - Open-source licensing - GPL, LGPL, BSD. Review Techniques - Cost impact of Software Defects, Code review and statistical analysis. Informal Review, Formal Technical Reviews, Post-mortem evaluations. Software testing strategies - Unit Testing, Integration Testing, Validation testing, System testing, Debugging, White box testing, Path testing, Control Structure testing, Black box testing, Testing Documentation and Help facilities. Test automation, Test-driven development, Security testing. Overview of DevOps and Code Management - Code management, DevOps automation, CI/CD/CD. Software Evolution - Evolution processes, Software maintenance.	**12**
4	**Software Project Management:**Software Project Management - Risk management, Managing people, Teamwork. Project Planning, Software pricing, Plan-driven development, Project scheduling, Agile planning. Estimation techniques, COCOMO cost modeling. Configuration management, Version management, System building, Change management, Release management, Agile software management - SCRUM framework. Kanban methodology and lean approaches.	**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	Interpret software process models and core activities, including handling changes with techniques like prototyping and incremental delivery.	**K2**
CO2	Describe agile methods, including the Agile Manifesto and agile project management practices.	**K2**
CO3	Prepare Software Requirement Specification and Software Design for a given problem	**K3**
CO4	Interpret object-oriented design principles, design patterns, software testing methods (including unit testing, integration testing, and test automation), and open-source licensing models (such as GPL, LGPL, and BSD).	**K2**
CO5	Describe software review techniques, DevOps practices and code management principles, and software evolution processes and maintenance strategies.	**K2**
CO6	Make use of software project management concepts while planning, estimation, scheduling, tracking and change management of a project, with proper application of SCRUM, Kanban and Lean frameworks.	**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**
CO2	**3**	**3**										**3**
CO3	**3**	**3**	**3**							**3**		**3**
CO4	**3**	**3**	**3**									**3**
CO5	**3**	**3**							**3**			**3**
CO6	**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	Software Engineering	Ian Sommerville	Pearson Education	Tenth edition, 2015
2	Software Engineering : A practitioner's approach	Roger S. Pressman	McGraw Hill publication	Eighth edition, 2014
3	Engineering Software Products: An Introduction to Modern Software Engineering	Ian Sommerville	Pearson Education	First Edition, 2020

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Kanban	David J. Anderson	Blue Hole Press	2010
2	Agile Management for Software Engineering	David J. Anderson	Pearson	2003
3	Software Project Management : A unified framework	Walker Royce	Pearson Education	1998
4	Implementing Lean Software Development: From Concept to Cash	Mary Poppendieck	Addison-Wesley Signature Series	2006

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106105182
2	https://nptel.ac.in/courses/106105182
3	https://nptel.ac.in/courses/106105182
4	https://nptel.ac.in/courses/106105218

SEMESTER S5

MODERN OPERATING SYSTEMS

Course Code	PEEOT521	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)	PEEET526	Course Type	Theory

Course Objectives:

1.To understand the overall working of computer system, tradeoffs between performance and functionality and the division of jobs between hardware and software.

2.Introduces the concepts of memory management, device management, process management, file management and security & protection mechanisms available in an operating system.

3.To understand the fundamentals about any operating system design

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction: Operating system overview – Functions, Boot Process Processes - Process states, Process control block, threads, scheduling, Operations on processes - process creation and termination Inter-process communication - shared memory systems, Message passing systems.	8
2	Process Scheduling – Basic concepts- Scheduling criteria -scheduling algorithms- First come First Served, Shortest Job Firs, Priority scheduling, Round robin scheduling Process synchronization- Race conditions – Critical section problem – Peterson's solution, Synchronization hardware, Mutex Locks, Semaphores, Monitors – Synchronization problems - Producer Consumer, Dining Philosophers and Readers-Writers.	10
3	Deadlocks: Necessary conditions, Resource allocation graphs, Deadlock prevention, Deadlock avoidance – Banker's algorithms, Deadlock detection, Recovery from deadlock.	10

	Memory Management: Concept of address spaces, Swapping, Contiguous memory allocation, fixed and variable partitions, Segmentation, Paging. Virtual memory, Demand paging, Page replacement algorithms.	
4	File System: File concept - Attributes, Operations, types, structure – Access methods, Protection. File-system implementation, Directory implementation. Allocation methods. Storage Management: Magnetic disks, Solid-state disks, Disk Structure, Disk scheduling, Disk formatting.	**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	Explain the relevance, structure and functions of Operating Systems in computing devices.	**K2**
CO2	Illustrate the concepts of process management and process scheduling mechanisms employed in Operating Systems.	**K2**
CO3	Explain process synchronization in Operating Systems and illustrate process synchronization mechanisms using Mutex Locks, Semaphores and Monitors	**K2**
CO4	Explain any one method for detection, prevention, avoidance and recovery for managing deadlocks in Operating Systems.	**K2**
CO5	Explain the memory management algorithms in Operating Systems.	**K2**
CO6	Explain the security aspects and algorithms for file and storage management in Operating Systems.	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	2	3	3							1		2
CO2	2	3	3	2						1		2
CO3	2	3	3	2						1		2
CO4	2	3	3	2						1		2
CO5	2	3	3	2						1		2
CO6	2	3	3	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	Operating System Concepts	Abraham Silberschatz, Peter Baer Galvin, Greg Gagne	Wiley India.	9th Edition, 2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Modern Operating Systems	Andrew S Tanenbaum	Pearson, Global Edition	6th Edition, 2015.
2	Operating Systems	Garry Nutt, Nabendu Chaki, Sarmistha Neogy	Pearson Education	3rd Edition,
3	Operating Systems	D.M.Dhamdhere	Tata McGraw Hill	2nd Edition, 2011.
4	Operating Systems	Sibsankar Haldar, Alex A Aravind	Pearson Education	

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://youtu.be/jciGIvn7UfM?si=iTyzYC1tztsAS8F4
2	https://youtu.be/I_7rthka2Is?si=kRo68aA_ozTBrNno

SEMESTER S5

INTRODUCTION TO SIGNALS AND SYSTEMS

Course Code	PEEOT522	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)	Engineering Math Courses	Course Type	Theory

Course Objectives:

1. To introduce time domain and frequency domain representation of continuous and discrete time signals and perform various mathematical operations
2. To introduce various types of signals and systems
3. To introduce time domain and frequency domain representation of continuous and discrete time systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Signals and Systems** Elementary Signals, Classification and representation of continuous time and discrete time signals, Signal operations. (3 hours) Concept of system: Continuous time and discrete time systems; Properties of systems: Time invariance, Linearity, Causality, Systems with and without memory, Stability. (3 hours) Convolution Integral and convolution sum (graphical and any one matrix method) (3 hours) Impulse and step response. (1 hour)	10
2	**Frequency domain characterization of Signals and Systems:** *Fourier transform:* Existence - Properties of Continuous time Fourier transform; Concept of Frequency response; Significance of Fourier	9

	transform and difference from Fourier series-Energy spectral density and power spectral density (4 hours) *Characterization of LTI systems:* Differential equation representation of continuous time LTI systems. Transfer function representation of differential equation in Laplace domain. (2 hours) *Modeling of LTI systems:* Electrical and translational Mechanical system - transfer function model (3 hours)	
3	**Sampled Data Systems and Z-Transform (9 hours)**: Sampling process - Impulse train sampling-sampling theorem- Aliasing effect. (2 hour) Zero-order and First-order hold circuits - Signal reconstruction. (2 hours) Z-transform: Stability and causality conditions using ROC. Characterization of difference equations using Z-transform. Pulse transfer function. Impulse response of discrete-time systems. (5 hours)	**9**
4	**Sampled Data System Representation and Fourier Analysis:** Delay operator and block diagram representation- Direct form, cascade and parallel representations (3 hours) Discrete Fourier series: Fourier representation of discrete time signals - Discrete Fourier series– properties. (2 hours) Discrete Time Fourier Transform: Properties- Frequency response of simple DT systems. (3 hours)	**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	To represent continuous and discrete time signals in time domain and perform various mathematical operations	**K2**
CO2	To represent continuous time signals and systems in frequency domain	**K3**
CO3	To represent discrete time signals and systems in Z-domain.	**K3**
CO4	To represent discrete time signals and systems in frequency domain	**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	1	2	1	3	3	3			3	2
CO2	3	3	2	2	2	3	3	3			3	2
CO3	3	3	2	2	2	3	3	3			3	2
CO4	3	2	1	2	1	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	Signals and Systems	Simon Haykin, Barry Van Veen	Wiley	2nd Edition, 2007
2	Discrete Time Control Systems	Katsuhiko Ogata	Pearson	2nd Edition, 2006
3	Control Systems Engineering	Norman S. Nise	Wiley	5th Edition, 2009

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Signals and Systems	Oppenheim A.V., Willsky A.S. & Nawab S.H.	Prentice Hall	2nd Edition, 2015
2	Modern Control Systems	Dorf R. C., Bishop R. H	Pearson Education India	12th Edition, 2013
3	Digital Signal Processing Principles	John G. Proakis & Dimitris G.Manolakis	Prentice Hall	4th Edition, 2007

SEMESTER: S5

POWER ELECTRONICS LAB

Course Code	**PCEOL507**	**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)	PCEOT402	**Course Type**	Lab

Course Objectives:

1.To motivate students to design and implement power electronic converters having high efficiency, small size, high reliability and low cost

2.To enable the students to select suitable power devices and passive components

3.To compare simulation results and hardware results and do iterative design

Expt. No.	Experiments **(Minimum 10 experiments are mandatory)**
	Suggestions: Students are encouraged to do the simulations associated with the experiments before the corresponding lab session so that more emphasis can be given to the hardware part in the lab (Simulations can be done off-lab) and the simulation results need to be correlated with the hardware results. For experiments where the effects of device parasitics cannot be neglected and circuit-level simulations are needed, SPICE based simulation software such as LTSpice™, OrCAD™, PSpice™, Proteus™ etc. may be used. In other cases, software like MATLAB Simulink™, SciLab™, SEQUEL™, PSIM™, PLECS™ etc. may be used if required.
	Preliminary work-1 ***(Mandatory)*** (a) Testing and Troubleshooting- Power diodes, SCR, Power Transistors, MOSFETS, IGBTS, OP-Amps, MOSFET drivers etc – Use of Multimeter, DSO, and Data sheets (b) Simulation of any Power Electronic circuit using a SPICE based software such as LTSpice, ORCAD, PSpice, and Proteus

1	**Static VI characteristics of Power Devices** **Aim:** To simulate the static VI characteristics of (a) Power Diode (b) SCR (b) MOSFET (c) IGBT using any suitable simulation software and compare with datasheet values
2	**High frequency diode - Measurement of power loss and reverse recovery time** **Aim:** To measure the power losses & reverse recovery time of a high frequency diode, compare with theoretical estimate and to compare with a schottky diode of similar ratings (Hardware/Simulation).
3	**Single-Phase half-wave-controlled rectifier feeding R/RL load** **Aim:** To simulate and set up a half-wave-controlled rectifier with line synchronized R and RC firing circuits and plot relevant waveforms such as voltage waveform across the load and thyristor, gate voltage and gate current for different firing angles. The need for line synchronization to be emphasized. (Any suitable simulation software may be used for the simulation)
4	**Single-Phase half-controlled(semi-converter)/fully-controlled rectifier feeding R/RL loads** **Aim:** To simulate and set up any type of line synchronized Triggering circuit such as UJT firing, Ramp firing, Digital firing etc. for single-phase half-controlled/full controlled rectifier feeding R and RL loads and observe relevant waveforms. The need for line synchronization to be emphasized (Any suitable simulation software may be used for the simulation).
5	**Effect of source inductance in single-phase controlled rectifier feeding highly inductive loads** **Aim:** To set up a single-phase full controlled rectifier with source inductance, for highly inductive loads, observe relevant waveforms and calculate the source power factor, line current THD and the average voltage lost due to the effect of source inductance (Simulation may be used to get more insights).
6	**Single-Phase half-controlled/fully-controlled Rectifier fed PMDC/Separately excited DC motor drive** **Aim:** To simulate and set up a single-phase half-controlled/full controlled rectifier feeding a PMDC/SEDC motor (additional inductor may be included in the armature circuit to get continuous conduction) and observe relevant waveforms (Any suitable simulation software may be used for the simulation)
7	**AC Voltage controller feeding R/RL loads** **Aim:** To set up a single-phase AC voltage controller using TRIAC/SCR and to

	observe relevant waveforms such as voltage waveforms across the load (R/RL Load) & TRIAC/SCR, gate voltage, gate current etc. for different firing angles (Simulation may be used to get more insights).
8	**Isolated Gate Driver Circuit for Single-phase half-Bridge IGBT/MOSFET Inverter** **Aim:** (a) To identify the gate current and voltage requirement to drive the MOSFET/IGBT in a half-bridge configuration for a certain switching frequency with galvanic isolation, to select suitable industry-standard IGBT/MOSFET driver ICs and to test the driver circuit both for floating and ground-referenced configurations, and to observe relevant waveforms (b) To simulate and set up a circuit for dead-time generation for use with the half-bridge inverter
9	**Gate drive using Bootstrap technique** **Aim:** To identify the gate current and voltage requirement to drive the MOSFET/IGBT with boot-strap technique for a certain switching frequency, understand the merits & pertinent limitations of the bootstrapping circuit and to explore dead-time and shutdown/over current protection options
10	**Single-phase half-bridge/full-bridge IGBT/MOSFET inverter feeding RL load** **Aim:** To simulate and set up a single-phase half-bridge inverter with L/LC filter for square wave and sine-triangle PWM, observe relevant waveforms and obtain THD (Any suitable simulation software may be used for the simulation)
11	**Inductor design and Fabrication** **Aim:** To design and fabricate an inductor to be used in a high frequency switching application and measure the inductance value using time constant measurement/LCR meter **Note:** The inductor may be designed taking into account the requirement in expt #12
12	**Design and set-up a buck/ boost /buck-boost converter** ***(Mandatory Experiment)*** **Aim:** (a) Design, simulate and set up a buck/boost/buck-boost converter (continuous conduction mode) and observe relevant waveforms (b) Compare the measured quantities such as capacitor voltage ripple and inductor current ripple with the designed values (c) Calculate power loss in power devices and select heat sink (and snubbers) needed if any (d) Overall efficiency computation and measurement of temperature of the heatsink and passive components (e) Explore performance improvement opportunities

	(Any suitable simulation software may be used for the simulation)
13	**Speed control of Permanent Magnet/Separately-Excited DC motor using chopper drive** **Aim:** To simulate and set up a One-quadrant/Two-quadrant DC chopper to control the speed of a PMDC/SEDC motor for operation in continuous conduction and observe relevant waveforms (Any suitable simulation software may be used for the simulation)
14	**Three-phase IGBT/MOSFET inverter feeding RL Load** **Aim:** To simulate and set up (Demo is sufficient) a three-phase inverter for (a) sine-triangle PWM (b) third-harmonic (or triple-n harmonic) injection PWM and observe relevant waveforms & THD. Influence of various parameters such as switching frequency, amplitude & frequency modulation indices, dead-time etc. on the performance may be studied (Any suitable simulation software may be used for the simulation).
15	**Stator Voltage control of Three-Phase Induction Motor** **Aim:** To set up (Demo is sufficient) a three-phase induction motor drive using stator voltage control and observe relevant waveforms & THD (Simulation may be used to get more insights).
16	**Single phase unidirectional/bidirectional interface – boost PWM rectifier** **Aim:** To set up (Demo is sufficient) a single-phase PWM rectifier with near unity power, observe relevant waveforms and obtain the line current THD/PF (Simulation may be used to get more insights).
17	**V/F control of Three-Phase Induction Motor** **Aim:** To simulate and set up (Demo is sufficient) a three-phase induction motor drive using V/F control and observe relevant waveforms & THD for different speeds of operation (Any suitable simulation software may be used for the simulation).

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	Understand the operation of modern power semiconductor devices, its characteristics and Design & Select suitable gate driver circuits & heatsinks	**K5**
CO2	Understand the features of phase-controlled rectifiers, AC voltage Controllers & Switching Regulators and Analyse the operation	**K4**
CO3	Understand the features of different types of switch mode DC-AC Inverters and Analyse the operation	**K3**
CO4	Understand the need for improved efficiency, improved reliability, improved load & source waveforms and improved utility interface	**K3**
CO5	Understand the features of adjustable speed drives and Analyse the basic drive schemes for DC motors and Induction Motors	**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									
CO2	3	1	3									
CO3	3	1	3									
CO4	3	1	3									
CO5	3	1	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- Essentials and Applications	L. Umanand	John Wiley	2009
2	Power Electronic Systems- Theory and Design	Jai P Agrawal	Pearson	2006
3	Power Electronics- Converters, Applications and Design, 3e (Indian Adaptation)	Ned Mohan, Undeland, Robbins	Wiley India	2022
4	Power electronics: principles and applications	Joseph Vithayathil	Tata McGraw Hill	2010
5	Power Electronics	D.W. Hart	McGraw Hill	2010

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Elements of Power Electronics	Philip T Krein	Oxford	2017
2	Power Electronics- Devices, Circuits and Applications	Muhammad H. Rashid,	Pearson	2014
3	Power Electronics	Cyril W Lander	McGrawHill	1993
4	Power Electronics- A first course: Simulations and Laboratory Implementations	Ned Mohan, Siddharth Raju	Wiley	2023
5	Power Electronics Step by Step- Design, Modeling, Simulation and Control	Weidong Xiao	McGrawHill	2021

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	Lecture Series on Power Electronics **by Prof. G. Bhuvaneswari**, IIT Delhi https://www.youtube.com/watch?v=Z2CORFayCv0&list=PLp6ek2hDcoND7i5-DAD9mPmYF1Wg6ROdO&index=3
2	NPTEL Lecture Series on Power Electronics by **Prof. L. Umanand**, IISc Bangalore https://www.youtube.com/watch?v=eLIdqiPMjBs&list=PLgMDNELGJ1CaXa4sX6QSrkhu-yP_Wu2EN&index=26
3	NPTEL Lecture Series by **Prof. Shabari Nath**, IIT Guwahati https://www.youtube.com/watch?v=S_UXW2UzAi8&list=PLwdnzlV3ogoWVgA9fHBV36L_bxWZlpa7X&index=7

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

MICROCONTROLLERS AND EMBEDDED SYSTEMS LAB

Course Code	**PCEOL508**	**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. Achieve proficiency in 8051 microcontroller assembly language and embedded C programming.
2. Acquire practical experience with Arduino.

Expt. No.	**Experiments**
1	ALP programming for (a) Data transfer: Block data movement, exchanging data, sorting, finding largest element in an array. (b)Arithmetic operations: Addition, Subtraction, Multiplication and Division. Comparing square and cube of 16 bit numbers.
2	ALP programming for the implementation of counters: Hex up and down counters, BCD up/down counters.
3	(a)ALP programming for implementing Boolean and logical instructions: bit manipulation. (b)ALP programming for implementing conditional call and return instructions: Toggle the bits of port 1 by sending the values of 55H and AAH continuously, Factorial of a number.
4	ALP program for Generation of delay.
5	C program for stepper motor control.
6	C program for DC motor direction and speed control using PWM.

7	C program for alphanumerical LCD panel/keyboard interface.
8	C program for ADC interfacing.
9	Demo experiment using 8051 Microcontroller programming. ALP programming for implementation code conversion- BCD to ASCII , ASCII to BCD, ASCII to Decimal , Decimal to ASCII, Hexadecimal to Decimal and Decimal to Hexadecimal
10	a)Familiarization of Aurdino IDE. b)LED blinking with different ON/OFF delay timings with (i) inbuilt LED (ii) externally interfaced LED.
11	Arduino based voltage measurement of 12 V solar PV module /12 V battery and displaying the measured value using 12C LCD display..
12	Demo experiments on Arduino / Raspberry Pi to upload /retrieve temperature and humidity data to thing speak cloud.
13	Arduino based DC current measurement using Hall effect current sensor displaying the value using 12C LCD module.
14	Directional control of the DC motor using Arduino.
15	Interfacing of the relay with Arduino.
16	Building intrusion detection system with Arduino and Ultrasonic sensor.

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 and execute ALP programs for solving arithmetic and logical problems using microcontroller	**K3**
CO2	Develop embedded C programming using instruction sets of 8051	**K3**
CO3	Examine circuits for interfacing processor with various peripheral devices	**K4**
CO4	Design a microcontroller based system with the help of various interfacing devices	**K6**
CO5	Design an Arduino based system with the help of various interfacing devices	**K6**

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							3
CO2	3	3	3	3	3							3
CO3	3	3	3	3	3							3
CO4	3	3	3	3	3							3
CO5	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	Kenneth Ayala	Cengage Learning	
2	Microprocessors and Microcontrollers	R. LylaB.Das	Pearson Education	

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	The 8051 Microcontroller	I. Scott Mac Kenzie, Raphael C.-W. Phan		
2	The 8051 microcontroller and embedded systems	Muhammad Ali Mazidi	Pearson Education	

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.
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4. **Viva Voce (5 Marks)**
    - Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

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Evaluation Pattern for End Semester Examination (50 Marks)

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- 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