CURRICULUM
&
SYLLABUS
2022 Scheme
(Autonomous)
Version 1.0

B.TECH
ELECTRICAL AND COMPUTER ENGINEERING

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

Mar Ivanios Vidyanagar, Nalanchira, Thiruvananthapuram – 695015

CURRICULUM AND DETAILED SYLLABI

FOR

B. TECH DEGREE PROGRAMME

IN

ELECTRICAL AND COMPUTER ENGINEERING

SEMESTERS V & VI

2022 SCHEME

(AUTONOMOUS)

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY
(Approved by AICTE, Autonomous Institution Affiliated to APJ Abdul Kalam Technological University)
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MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

B. TECH DEGREE PROGRAMME

IN

ELECTRICAL AND COMPUTER ENGINEERING

THIRD YEAR SYLLABUS

2022 SCHEME

Items	Board of Studies (BOS)	Academic Council (AC)
Date of Approval	01.04.2024	19.06.2024

Head of Department
Chairman, Board of Studies

Principal
Chairman, Academic Council

MAR BASELIOS COLLEGE OF ENGINEERING & TECHNOLOGY
(Autonomous)
Mar Ivanios Vidyanagar
Nalanchira
Thiruvananthapuram-695015

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

Vision and Mission of the Institution

Vision:

To be an Institution moulding globally competent professionals as epitomes of Noble Values.

Mission:

To transform the Youth as technically competent, ethically sound and socially committed professionals, by providing a vibrant learning ambience for the welfare of humanity.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Vision and Mission of the Department

Vision:

To be a Centre of Excellence in Electrical & Electronics Engineering Education, Research and Application of knowledge to benefit the society at large.

Mission:

To mould quality Electrical Engineers, fostering creativity and innovation to address global issues.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Graduates will succeed as Engineering Professionals in Industry or as Entrepreneurs in Electrical and Computer Engineering and the related disciplines and exhibit an urge for innovation.

PEO2: Graduates will be able to adapt to the advances in Technology by acquiring knowledge and skills manifested through continuous learning and higher qualifications.

PEO3: Graduates will be serving community as socially committed individuals, exhibiting professional ethics in addressing the technical and engineering challenges.

PROGRAMME OUTCOMES (POs)

Engineering graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1: To apply the knowledge in Electrical Engineering and Computer Engineering for the design, development testing and operation of Power and Energy Systems in the areas of Generation, Transmission, Conversion, Distribution and Utilization systems.

PSO2: To apply the knowledge in Electrical Engineering and Computer Engineering for the design, development and operation of Industrial systems in the areas of Automation, Control, Energy Management and Economic operation.

CURRICULUM

SEMESTER V						
Slot	**Cate-gory Code**	**Course Code**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	PCC	EL2U30A	Database Management Systems	3-1-0	4	4
B	PCC	EL2U30B	Microprocessors and Embedded Systems	3-1-0	4	4
C	PCC	EL2U30C	Electrical Machines	3-1-0	4	4
D	HSC	HS0U30B	Management for Engineers	3-0-0	3	3
E	PEC	EL2UXXX	Program Elective I	3-0-0	3	3
F	MNC	NC0U30A	Disaster Management	2-0-0	2	--
S	PCC	EL2U38A	Electrical Machines Lab	0-0-3	3	2
T	PCC	EL2U38B	Database Management System Lab	0-0-3	3	2
R/M/H	VAC		Remedial/Minor/Honours Course	2-0-0	4	4
TOTAL					**26/30**	**22/26**

PROGRAMME ELECTIVE I

Slot	**Category Code**	**Course Code**	**Courses**	**L-T-P**	**Hours**	**Credit**
D	PEC	EL2U31A	Signals and Systems	3-0-0	3	3
		EL2U31B	Foundations of Security in Computing	3-0-0	3	3
		EL2U31C	Biomedical Instrumentation	3-0-0	3	3
		EL2U31D	Renewable Energy Conversions	3-0-0	3	3
		EL2U31E	Programming In Python	3-0-0	3	3
		EL2U31F	Operating Systems	3-0-0	3	3
		EL2U31G	Foundations of Machine Learning	3-0-0	3	3
		EL2U31H	Wireless Sensor Networks	3-0-0	3	3

SEMESTER VI						
Slot	**Cate-gory Code**	**Course Code**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	PCC	EL2U30D	Power Electronics and Drives	3-1-0	4	4
B	PCC	EL2U30E	Internet of Things	3-1-0	4	4
C	PCC	EL2U30F	Computer Communication and Network Security	3-1-0	4	4
D	PCC	EL2U30G	Algorithm Analysis and Design	3-0-0	3	3
E	PEC	EL2UXXX	Program Elective II	3-0-0	3	3
F	PCC	EL2U30H	Comprehensive Course Work	1-0-0	1	1
S	PCC	EL2U38C	Embedded Systems and IOT Lab	0-0-3	3	2
T	PCC	EL2U38D	Networking Lab	0-0-3	3	2
R/M/H	VAC		Remedial/Minor/Honours Course	3-1-0	4	4
TOTAL					**25/29**	**23/27**

PROGRAMME ELECTIVE II

Slot	**Category Code**	**Course Code**	**Courses**	**L-T-P**	**Hours**	**Credit**
D	PEC	EL2U32A	Advanced Microcontrollers	3-0-0	3	3
		EL2U32B	Electromagnetic Theory and Compatibility	3-0-0	3	3
		EL2U32C	Energy Storage Systems	3-0-0	3	3
		EL2U32D	Digital Image Processing	3-0-0	3	3
		EL2U32E	Modern Illumination Control	3-0-0	3	3
		EL2U32F	Introduction to Artificial Intelligence	3-0-0	3	3
		EL2U32G	Soft Computing Techniques	3-0-0	3	3
		EL2U32H	Introduction to Signal Processing	3-0-0	3	3

B.Tech (MINORS)

SEMESTER 5

Course Code	Courses	L-T-P	Credit
EL0M30I	Energy Storage Devices	3-1-0	4
EL0M30J	Solar and Wind Energy Conversion Systems	3-1-0	4
EL0M30K	Raspberry Pi Platform Interface & Python Programming	3-1-0	4
EL0M30L	Energy efficiency in Buildings	4-0-0	4

SEMESTER 6

Course Code	Courses	L-T-P	Credit
EL0M30M	Hybrid and Electric Vehicles	3-1-0	4
EL0M30N	Instrumentation and Automation of Power Plants	4-0-0	4
EL0M30P	Cloud Services and Internet of Things	4-0-0	4
EL0M30Q	Electrical System Design and Building services	3-1-0	4

B.Tech (HONOURS)

SEMESTER 5

Course Code	Courses	L-T-P	Credit
EL2H30A	Process Automation	4-0-0	4
EL2H30B	Mathematics for Machine Learning	4-0-0	4
EL2H30C	Micro Grids	4-0-0	4
EL2H30D	Electric Vehicle Technology	4-0-0	4

SEMESTER 6

Course Code	Courses	L-T-P	Credit
EL2H30E	Introduction to Navigation and Trajectory planning	3-1-0	4
EL2H30F	Introduction to Machine Learning	3-1-0	4
EL2H30G	Distributed Generation and Smart Grid	3-1-0	4
EL2H30H	Automotive Electronic systems	4-0-0	4

SEMESTER V

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U30A	DATABASE MANAGEMENT SYSTEMS	PCC	3	1	0	4	2022

i) PRE-REQUISITE: EL2U20B: Data Structures, Exposure to a High-level Language like C/Python.

ii) COURSE OVERVIEW:

This course offers learners a comprehensive grasp of the core principles of Database Management Systems (DBMS), with a particular emphasis on relational databases. The topics covered in this course are basic concepts of DBMS, Entity Relationship (ER) model, Relational Database principles, Relational Algebra, Structured Query Language (SQL), Physical Data Organization, Normalization and Transaction Processing Concepts. The course also gives a glimpse of the alternative data management model, NoSQL. This course helps the learners to manage data efficiently by identifying suitable structures to maintain data assets of organizations and to develop applications that utilize database technologies.

iii) COURSE OUTCOMES

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

CO 1	Summarize and illustrate fundamental nature and characteristics of database systems	Understand
CO 2	Model real world scenarios given as informal descriptions, using Entity Relationship diagrams.	Apply
CO 3	Model and design solutions for efficiently representing and querying data using relational model	Apply
CO 4	Apply the features of indexing and hashing in database applications	Apply
CO 5	Identify and compare the aspects of Concurrency Control and Recovery in Database systems	Apply
CO 6	Make use of Redis, MongoDB, Cassandra, ArangoDB to explain the various NoSQL databases	Apply

iv) SYLLABUS

Concept & Overview of Database Management Systems (DBMS), Database Languages, Database architectures and classification.

ER models. Structure of Relational Databases, Synthesizing ER diagram to relational Schema, Introduction to Relational Algebra, introduction to Structured Query Language (SQL), formation of SQL queries using SQL DML (Data Manipulation Language), Physical Data organization, Heap files, Indexing, Singe level and multi-level indices.

B trees, Hashing and indexing, Different anomalies in designing a database and different types of normalization applied to Databases.

Transaction Processing Concepts, concurrency control and recovery, Introduction to noSQL Databases.

Explanation of main characteristics using Redis, MongoDB, Arrango DB, Cassandra.

(a) TEXT BOOKS

1) Elmasri R. and S. Navathe, Database Systems: Models, Languages, Design and Application Programming, Pearson Education, 2013.
2) Sliberschatz A., H. F. Korth and S. Sudarshan, Database System Concepts, 6/e, McGraw Hill, 2011.

(b) REFERENCES

1) Adam Fowler, NoSQL for Dummies, John Wiley & Sons, 2015.
2) NoSQL Data Models: Trends and Challenges (Computer Engineering: Databases and Big Data), Wiley, 2018.
3) Web Resource: https://www.w3resource.com/redis/
4) Web Resource: https://www.tutorialspoint.com/cassandra/cassandra_introduction.htm
5) web Resource: https://www.w3schools.in/category/mongodb/
6) Web Resource : https://www.tutorialspoint.com/arangodb/index.htm

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction & Entity Relationship (ER) Model:** Concept & Overview of Database Management Systems (DBMS) - Characteristics of Database system, Database Users, structured, semi-structured and unstructured data. Data Models and Schema - Three Schema architecture. Database Languages, Database architectures and classification. ER model - Basic concepts, entity set & attributes, notations, Relationships and constraints, cardinality, participation, notations, weak entities, relationships of degree 3.	12
II	**Relational Model:** Structure of Relational Databases - Integrity Constraints, Synthesizing ER diagram to relational schema. Introduction to Relational Algebra - select, project, cartesian product operations, join - Equi-join, natural join. query examples, introduction to Structured Query Language (SQL), Data Definition Language (DDL), Table definitions and operations – CREATE, DROP, ALTER, INSERT, DELETE, UPDATE.	12
III	**SQL DML (Data Manipulation Language), Physical Data Organization:** 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. Physical Data Organization - Review of terms: physical and logical records, blocking factor, pinned and unpinned organization. Heap files, Indexing, Single level indices, numerical examples, Multi-level-indices, numerical examples, B-Trees & B+-Trees (structure only, algorithms not required), Extendible Hashing, Indexing on multiple keys – grid files.	12
IV	**Normalization:** 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.	12

V	**Transactions, Concurrency and Recovery, Recent Topics:** 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 Redis), Document DB (examples from MongoDB) Main characteristics of Column - Family DB (examples from Cassandra) and Graph DB (examples from ArangoDB)	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U30B	MICROPROCESSORS AND EMBEDDED SYSTEMS	PCC	3	1	0	4	2022

i) PRE-REQUISITE: EL2U20D - Computer Organization and Architecture, EL2U20F - Digital Electronics

ii) COURSE OVERVIEW:

This course is designed to introduce microcontroller assembly language programming. Students will be taught the basic use of an assembly as well as embedded C programming environment to control peripheral devices. Students will also understand the interfacing of various peripheral elements with microcontrollers to design an automated system. The course prepares the student with a set of concepts common to many different embedded systems.

iii) COURSE OUTCOMES

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

CO 1	Explain the architecture of a microprocessor and microcontroller-based system.	Understand
CO 2	Develop Assembly language program for 8085 microprocessor and 8051 microcontrollers.	Apply
CO 3	Construct embedded C program for I/O port, serial port communication and time delay using timers/counters of 8051.	Apply
CO 4	Develop embedded C program to interface various peripheral devices with 8051 microcontrollers	Apply
CO 5	Explain the general characteristics and life cycle development of an embedded system.	Understand

iv) SYLLABUS

Internal architecture of 8085 microprocessor, Machine cycles and T states – Fetch and execute cycles- Timing diagram for instruction and data flow. Assembly language programs for 8085 microprocessors.

Architecture of 8051 Microcontrollers, Assembly programming for 8051 microcontrollers, Embedded C programs for I/O port, serial port communication, timer/counter, interfacing external peripherals.

Overview of embedded systems, Current trends and challenges, Product development life cycle.

v) (a) TEXT BOOKS

3) Douglas V. Hall, *Microprocessors and Interfacing*, Tata McGraw Hill, Education Pvt. Ltd, 2012 Edition.
4) Mathur A., *Introduction to Microprocessors*, Tata McGraw Hill, New Delhi, 2015 Edition.
5) Ramesh Gaonkar, *Microprocessor, Architecture, Programming and Applications*, Pen ram, Fifth Edition, 2000.
6) Muhammad Ali Maidu and Janice Gillespie, *The 8051 Microcontroller and Embedded Systems – using assembly and C*, Pearson, Second Edition 2007.
7) Kenneth J. Ayala, *The 8051 Microcontroller*, 3rd Edition, Thomson/Cengage Learning, 2nd Edition 2007.

(b) REFERENCES

1) Ramesh Gaonkar, *Fundamentals of Microcontrollers and Applications in Embedded Systems (with the PIC18 Microcontroller Family)*, January 2010.
2) Manish K Patel, *The 8051 Microcontroller Based Embedded Systems*, McGraw Hill, July 2017, ISBN: 978-93-329-0125-4.
3) Raj Kamal, *Microcontrollers: Architecture, Programming, Interfacing and System Design*, Pearson Education, January 2011.
4) K.Uma Rao & Andhe Pallavi, *The 8051 microcontrollers, architecture and programming and applications,* Pearson, January 2010.
5) Ajay V. Deshmukh, *Microcontrollers and application*, Tata McGraw-Hill Publishing Company Limited, New Delhi,2005.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Internal architecture of 8085 microprocessor–Functional block diagram. Instruction set-Addressing modes - Classification of instructions - Status flags. Machine cycles and T states – Fetch and execute cycles- Timing diagram for instruction and data flow.	**10**
II	Assembly language program (ALP) in 8085 microprocessor- Arithmetic operations, Code conversion- BCD to Binary - Binary to BCD, Bubble sort Architecture of Intel 8051 microcontroller, 8051 Register Banks and Stack, Internal Memory Organization of 8051, SFR	**14**
III	Introduction to 8051 assembly programming, Data types and Assembler directives, 8051 Addressing Modes, simple Assembly programs. Data types and time delay in 8051C, I/O programming in 8051C, Logic operations in 8051 C, Data conversion program in 8051 C. Programming 8051 timers, Counter programming, Programming timers 0 and 1 in 8051 C.	**14**
IV	Basics of serial communication, 8051 connections to RS232, serial port programming in 8051 C. Interfacing LCD, seven segment display, DIP switches, ADC, DAC, Stepper motor, DC motor.	**14**
V	Overview of Embedded Systems - Application domain of embedded systems, features and characteristics, overview of embedded system architecture; recent trends in embedded systems, Categories of embedded systems-Hard and soft, Design and Development life cycle model, Challenges in Embedded system design	**8**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U30C	ELECTRICAL MACHINES	PCC	3	1	0	4	2022

i) PRE-REQUISITE: PH0U10A Engineering Physics, ES0U10D Basics of Electrical & Electronics Engineering

ii) COURSE OVERVIEW: The goal of this course is to expose students to the fundamental concepts of DC machines, Induction motors and Synchronous machines including constructional details, principle of operation, performance and applications. It introduces students to cognitive learning and develops problem solving skills.

iii) COURSE OUTCOMES

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

CO1	Explain the principle of operation and characteristics of DC generators.	Understand
CO2	Solve problems based on the speed and torque characteristics of different types of DC motors and select suitable motors for various applications.	Apply
CO3	Develop the equivalent circuit and determine the efficiency of transformers and auto-transformers.	Apply
CO4	Explain the principle of operation and types of three phase and single-phase Induction machines.	Understand
CO5	Describe the principle of operation of alternators and synchronous motors and determine the regulation of alternators.	Understand

iv) SYLLABUS

DC generators: principle of operation -emf equation-types of excitations - armature reaction, OCC.

Principle of operation of DC motors - torque and speed equations- characteristics- applications of DC shunt, series and compound motors - starters - losses and efficiency – load test.

Transformers – principle of operation – emf equation- phasor diagram- losses and efficiency – OC and SC tests - equivalent circuits - maximum efficiency – all day efficiency – auto transformers.

Three phase induction motors- types - principle of operation – torque slip characteristics- no load and blocked rotor tests - Circle diagram - methods of starting.

Single phase motors- principle of operation - resistance split phase motor – capacitor start motor- stepper motors, universal motors. Synchronous machines: construction– emf equation of alternator – regulation of alternator by emf method - synchronous motors- methods of starting- V curves, synchronous condenser. BLDC motors - Principle - emf equation, torque equation

v) (a) TEXT BOOKS

1) Bhimbra P. S., “Electric Machines”, Khanna Publishers, 2nd Edition, 2017.
2) Fitzgerald A. E., Kingsley C. and Umans S., “Electric Machinery”, McGraw Hill, 6th Edition, 2003.
3) Theodore Wilde, “Electrical Machines, Drives and Power System”, Pearson Education. Asia,6th Edition, 2013.
4) Kothari D. P., Nagrath I. J., “Electric Machines”, Tata McGraw Hill, 5th Edition, 2004.

(b) REFERENCES

1) Gupta J. B., "Theory and Performance of Electrical Machines", S K Kataria & Sons, 14th Edition, 2013.
2) Deshpande M. V., "Electrical Machines", Prentice Hall India, New Delhi, Eastern Economy Edition, 2011.
3) S.K. Bhattacharya, "Electrical Machines", Tata McGraw-Hill Publishing Company Limited, New Delhi.
4) M.G. Say, "Performance and Design of Direct Current Machines", CBS publishers, New Delhi, 1993.
5) Ashfaq Husain, Haroon Ashfaq, "Electric Machines" Dhanpat Rai and Co., 3rd Edition.
6) Clayton A. E. and Hancock N. N., "The Performance and Design of Direct Current Machines", CBS Publishers & Distributors, New Delhi, 3rd Edition, 2004.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**DC Machines**- Principles of electromechanical energy conversion, DC generators: principle of operation -emf equation-types of excitations. Separately excited, shunt and series excited DC generators, compound generators. Concept of armature reaction, OCC - simple numerical problems.	**12**
II	**DC motors:** Principle of operation-torque and speed equations- characteristics of DC motors- applications of DC shunt, series and compound motors - concept of starters - losses and efficiency – load test- simple numerical problems.	**12**
III	**Transformers** – principle of operation – emf equation- phasor diagram- losses and efficiency – OC and SC tests - equivalent circuits - efficiency calculations- maximum efficiency – all day efficiency – auto transformers - simple numerical problems	**12**
IV	**Three phase induction motors**- slip ring and squirrel cage types - principle of operation – rotating magnetic field- torque slip characteristics- no load and blocked rotor tests - Circle diagram - methods of starting – star-delta starting, auto transformer starting.	**12**
V	**Single phase motors**- principle of operation of single-phase induction motors – resistance split phase motor – capacitor start motor- stepper motors, universal motors. **Synchronous machines**: construction– principle - emf equation of alternator –concept of regulation of alternator by emf method. Principles of operation of synchronous motors- methods of starting- V curves, synchronous condenser**.** BLDC Motors: Principle - emf equation, torque equation (concept only)	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE2U31A	SIGNALS AND SYSTEMS	PEC	3	0	0	3	2022

i) **PRE-REQUISITE:** MA0U10A: Linear Algebra and Calculus, MA0U10B: Vector Calculus, Differential Equations and Transforms, MA0U20A: Partial Differential Equations and Complex Analysis.

ii) **COURSE OVERVIEW**: This course aims to impart knowledge about the representation and properties of signals and systems and its applications in engineering and technology.

iii) **COURSE OUTCOMES**

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

CO 1	Apply the basic operations on signals and systems.	Apply
CO 2	Apply Fourier Series and Fourier Transform concepts for continuous time signals.	Apply
CO 3	Make use of Laplace Transform for continuous time systems	Apply
CO 4	Make use of Z Transform for discrete time systems	Apply

iv) **SYLLABUS**

Basics of signals- operation on signals; Classification of systems; Representation of LTI Systems. Fourier analysis of continuous time signals; Fourier transform- properties; Frequency response of LTI Systems. Laplace Transform analysis of systems- Time and Frequency responses.
Sampling- signal reconstruction, Z Transform- Region of convergence- properties;
Solution of LTI Systems using Z transform method.

v) (a) TEXT BOOKS

1) Haykin S. & Veen B.V., "*Signals & Systems*", John Wiley Publications, 2nd edition, 2007.
2) Oppenheim A.V, Willsky A.S. & Nawab S.H., "*Signals and Systems*", Pearson Publications, 2nd edition, 2015.
3) I J Nagrarth, "*Signals and Systems*", McGraw Hill Education, 2009.
4) P.Ramesh Babu, R. Anandanadarajan, "*Signals and Systems*", SCITECH Publications Pvt. Ltd, 2008.
5) Dr. D. Ganesh Rao, Satish Tunga," *Signals and Systems*", Cengage India Private Limited, 2017.

(b) REFERENCES

1) Bracewell R.N., "*Fourier Transform & Its Applications*", McGraw Hill Education, 1999.
2) Farooq Husain, "*Signals and Systems*", Umesh Publications, 2017.
3) Papoulis A., "*Fourier Integral & Its Applications*", McGraw-Hill Book Company, 1962.
4) Taylor F.J., Principles of Signals & Systems, McGraw Hill

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Signals and Systems: Classification of signals: Elementary Signals - Basic operations on continuous time and discrete time signals. Concept of system: Classification of systems- Properties of systems- Impulse response. Representation of LTI systems: Differential equation representations of LTI systems.	**10**
II	Fourier Analysis: Fourier analysis of continuous time signals: Fourier Series- Harmonic analysis of common signals. Fourier transform: Existence- Properties of Continuous time Fourier transform- Concept of Frequency response.	**9**
III	Laplace transform analysis of systems - relation between the transfer function and differential equation –causality and stability - inverse system - determining the time domain and frequency response from poles and zeros.	**9**
IV	Sampled data systems- Sampling process-sampling theorem signal re construction- Zero order and First order hold circuits- Z Transform - Region of convergence- Properties of the Z transform – Inverse ZT-methods	**9**
V	Difference equation representations of LTI systems - Z-transfer function - Analysis of difference equation of LTI systems - Basic idea on Stability and causality conditions.	**8**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii. MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U31B	FOUNDATIONS OF SECURITY IN COMPUTING	PEC	3	0	0	3	2022

i) PREREQUISITE: - Nil

ii) COURSE OVERVIEW: This course helps the learners to explore various algorithms to offer confidentiality, integrity, authentication & non-repudiation services and different attacks on system security with their countermeasures. It covers classical encryption techniques, symmetric and public key crypto-system, key distribution techniques, authentication functions, intruders, malicious software, and DDoS attacks. The concepts covered in this course enable the learners in effective use of cryptographic algorithms and appropriate countermeasures for securing real life applications.

iii) COURSE OUTCOMES

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

CO 1	Outline the security services provided against different types of security attacks.	Understand
CO 2	Illustrate classical encryption techniques for information hiding.	Understand
CO 3	Explain symmetric/asymmetric key crypto systems for secure communication.	Understand
CO 4	Interpret public/secret key distribution techniques for secure communication.	Understand
CO 5	Demonstrate the effects of intruders, malicious software and distributed denial of service attacks on system security.	Understand

iv) SYLLABUS

Integer arithmetic, Euclid's algorithm for GCD, Extended Euclid's algorithm, Linear Diophantine Equations. Modular. Algebraic structures - Groups, Rings, Fields, Finite fields, GF(p), GF (2n).

Prime numbers - Prime numbers and prime-power factorization, Fermat and Mersenne primes, Fermat's theorem, Euler's theorem, Euler's totient function– Deterministic algorithms and Probabilistic algorithms. Factorization - Fermat's factorization, Pollard p-1 method.

Linear congruence, Chinese Remainder Theorem (CRT). Congruence with a prime, Arithmetic modulo p, Pseudoprimes, and Carmichael numbers. Primitive roots - Existence of primitive roots for primes, Discrete logarithms. Elliptic curve arithmetic.

Introduction to computer security – Threats, Vulnerabilities, Controls. Introduction to programming security. Operating system security. Database security.

v) (a) TEXTBOOKS

1. William Stallings, Cryptography and Network Security Principles and Practice, Fourth edition, Pearson Ed.
2. Behrouz A Forouzan, Cryptography and Network Security, Third edition, Tata McGraw-Hill.

(b) Reference Books

1. Charles P Pfleeger, Shari Lawrence Pfleeger, Jonathan Margulies, Security in Computing, Fifth edition, Prentice Hall.
2. G.A. Jones & J.M. Jones, Elementary Number Theory, Springer UTM, 2007.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Integer arithmetic - Integer division, Divisibility, Greatest Common Divisor (GCD), Euclid's algorithm for GCD, Extended Euclid's algorithm, Linear Diophantine Equations. Modular arithmetic - Operations, Properties. Algebraic structures - Groups, Rings, Fields, Finite fields, GF(p), GF (2n).	**9**
II	Prime numbers - Prime numbers and prime-power factorization, Fermat and Mersenne primes, Fermat's theorem, Applications, Euler's theorem, Euler's totient function, Applications. Primality testing – Deterministic algorithms and Probabilistic algorithms. Factorization - Fermat's factorization, Pollard p-1 method.	**9**
III	Linear congruence - Simultaneous linear congruence, Chinese Remainder Theorem (CRT). Congruence with a prime - Power modulus, Arithmetic modulo p, Pseudoprimes, and Carmichael numbers, Solving congruence modulo prime powers. Primitive roots - Existence of primitive roots for primes, Discrete logarithms. Elliptic curve arithmetic – Prime curves, Binary curves, Addition of two points, Multiplication of a point by a constant.	**10**
IV	Introduction to computer security – Threats, Vulnerabilities, Controls. Browser attack types, Web attacks targeting users, and Email attack types. Introduction to programming security - non-malicious programming oversights, Malware.	**8**
V	Operating system security – security in the operating system, Security in the design of the operating system. Database security – Security requirements of databases, Reliability, and integrity, Database disclosure.	**9**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U31C	BIOMEDICAL INSTRUMENTATION	PEC	3	0	0	3	2022

i) PRE-REQUISITE: EL2U20C Instrumentation Systems

ii) COURSE OVERVIEW:

Goal of this course is to provide an overview of instrumentation systems used in clinical medicine and biomedical research. The course is designed to give the basic concepts of Instrumentation involved in the medical field and human physiology. Biomedical Instrumentation is application of technology for medical field. During the course, students will explore Electro- physiological measurements, medical imaging etc. The course will make the students understand the devices used in diagnosing diseases.

iii) COURSE OUTCOMES

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

CO 1	Interpret the basics concepts of anatomy and physiology.	Understand
CO 2	Explain different techniques for the measurement of various physiological parameters.	Understand
CO 3	Illustrate modern imaging techniques for medical diagnosis	Understand
CO 4	Summarize the various therapeutic equipment used in biomedical field	Understand
CO 5	Outline the patient safety measures and recent advancements in the medical field.	Understand

iv) SYLLABUS

Introduction to biomedical instrumentation, Physiology and Anatomy of human body, Bioelectric potential, Bio potential Electrodes, Transducers for biomedical applications. Measurement of blood pressure, blood flow, cardiac output, Plethysmography, heart sounds. ECG, ECG and EMG block diagram, electrodes, waveforms and features, Measurements of respiratory parameters. Modern Imaging System, Therapeutic equipment, Test on blood cells. Physiological effects of electric current, Introduction to Tele- medicine - Introduction to medical robotics.

v) (a) TEXT BOOKS

1) Leslie Cromwell and F.J. Weibell, E.A. Pfeiffer, Biomedical Instrumentation and Measurements, Prentice Hall India, 2nd edition, 1990.
2) Carr & Brown, Biomedical Equipment Technology, 4th edition, Pearson, 2002.
3) R.S. Khandpur, HandBook of Biomedical instrumentation, 3rd edition, Tata McGraw Hill Publishing Co Ltd., 2014.

(b) REFERENCES

1) John G Webster, *Medical Instrumentation - Application and Design*, 4th edition, John Wiley and Sons, 2007.
2) L.A. Geddes and L.E. Baker, *Principles of Applied Biomedical Instrumentation*, John Wiley & Sons, 1975.
3) Andrew G Webb, *Principles of Biomedical Instrumentation,* Cambridge university press, 2018.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to biomedical instrumentation:** Man Instrumentation system- Problems encountered in measuring living systems, **Human Physiological systems:** Brief discussion of Heart and Cardio-vascular system-Physiology of Respiratory system - Anatomy of Nervous and Muscular systems. **Bioelectric potential:** Resting and action potential - Generation and propagation. **Bio potential Electrodes:** Theory – Surface electrode – Microelectrode - Needle electrodes. **Transducers for biomedical applications:** Transducers for the measurement of pressure, temperature and respiration rate.	9
II	**Measurement of blood pressure:** Direct and indirect measurement – Oscillo metric method –Ultrasonic method - Measurement of blood flow and cardiac output - Plethysmography –Photoelectric and Impedance Plethysmography - Measurement of heart sounds –Phonocardiography. **Cardiac measurements:** Electro-cardiography – Electrodes and leads – Einthoven triangle- ECG read out devices - ECG machine – block diagram	9
III	**Measurements from the nervous system:** EEG waveforms and features - 10-20 electrode measurement - EEG Block diagram. **Muscle response:** Electromyography- Block diagram of EMG recorders – Nerve conduction velocity measurement. **Measurements of respiratory parameters:** Spirometer – Pneumography, Finger-tip oximeter.	9
IV	**Modern Imaging Systems:** Basic X-ray machines - CAT scanner - Principle of operation -scanning components - Ultrasonic Imaging principle - types of Ultrasound Imaging - MRI and PET scanning (Principle only), Retinal Imaging - Imaging application in Biometric systems. **Therapeutic equipment:** Cardiac Pacemakers - Defibrillators - Hemodialysis machines - Artificial kidney – Lithotripsy - Shortwave and Microwave Diathermy machines, Ventilators - Heart Lung machine - Infant Incubators.	10
V	**Instruments for clinical laboratory:** Test on blood cells – Chemical tests. **Electrical safety:** Physiological effects of electric current – Shock hazards from electrical equipment – Method of accident prevention. **Introduction to Tele- medicine** - Introduction to medical robotics, Nano robots, Robotic surgery, Orthopedic prosthesis fixation.	8
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	**50**	**100**	**3 hours**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U31D	RENEWABLE ENERGY CONVERSIONS.	PEC	3	0	0	3	2022

i) **PREREQUISITE:** Students who have taken EE0M30B MINOR are not eligible to take this course.

ii) **COURSE OVERVIEW**: The goal of this course is to expose the students to learn the concepts of solar thermal and solar electric systems. It illustrates the operating principles of wind, and ocean energy conversion systems and the features of biomass and small hydro energy resources. The course describes the concepts of fuel cell and hydrogen energy technologies.

iii) **COURSE OUTCOMES**

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

CO 1	Explain the concepts of solar thermal and solar electric systems.	Understand
CO 2	Explain the concepts of ocean thermal energy conversion systems and tidal power plants.	Understand
CO 3	Illustrate the operating principles of wind energy conversion systems.	Understand
CO 4	Outline the features of biomass energy and small hydro power.	Understand
CO 5	Illustrate the concepts of fuel cell, hydrogen energy and different energy storage methods.	Understand

iv) SYLLABUS

Introduction, Classification of Energy Resources,

Principle of Conversion of Solar Radiation into Heat, Solar Thermal Electric Power Generation, Solar Photovoltaic, Solar PV Systems. Ocean Thermal Energy Conversion, Tidal power plants. Wind Energy Conversion Systems -Betz limit. Biomass conversion technologies. Small Hydro Power, Fuel Cell-principle of operation, Hydrogen energy, Energy storage –necessity and different methods.

v) (a) TEXT BOOKS

1) G. D. Rai, “Non-Conventional Energy Sources”, Khanna Publishers, 2010.
2) Rao S. and B. B. Parulekar, “Energy Technology”, Khanna Publishers, 1999.

(b) REFERENCES

1) G.N. Tiwari, “Solar Energy-Fundamentals, Design, Modelling and Applications”, Narosa Publishers, 2002.
2) Earnest J. and T. Wizelius, “Wind Power Plants and Project Development”, PHI Learning, 2011.
3) Sab S. L., “Renewable and Novel Energy Sources”, MI. Publications, 1995.
4) Sawhney G. S., “Non-Conventional Energy Resources”, PHI Learning, 2012.

5) Tiwari G. N., "Solar Energy- Fundamentals, Design, Modelling and Applications", CRC Press, 2002.
6) A.A.M. Saigh (Ed), "Solar Energy Engineering", Academic Press, 1977
7) Abbasi S. A. and N. Abbasi, "Renewable Energy Sources and Their Environmental Impact", Prentice Hall of India, 2001.
8) Boyle G. (ed.), "Renewable Energy - Power for Sustainable Future", Oxford University Press, 1996
9) Earnest J. and T. Wizelius, "Wind Power Plants and Project Development", PHI Learning, 2011.
10) F. Kreith and J.F. Kreider: "Principles of Solar Engineering", McGraw Hill, 1978.
11) Khan B.H, "Non-Conventional Energy resources", Tata McGraw Hill, 2009.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction, Classification of Energy Resources- Conventional Energy Resources - Availability and their limitations- Non-Conventional Energy Resources – Classification, Advantages, Limitations; Comparison. SOLAR THERMAL SYSTEMS- Principle of Conversion of Solar Radiation into Heat – Solar thermal collectors. – Flat plate collectors. Solar concentrators (parabolic trough, parabolic dish, Central Tower Collector). SOLAR ELECTRIC SYSTEMS - Solar Thermal Electric Power Generation – Solar Photovoltaic – Solar Cell fundamentals - characteristics, classification, construction. Solar PV Systems – stand-alone and grid connected- PV Panel Design.	**11**
II	ENERGY FROM OCEAN - Ocean Thermal Energy Conversion (OTEC)- Principle of OTEC system - Open Cycle (Claude cycle), Closed Cycle (Anderson cycle) and Hybrid cycle. Site-selection criteria- Biofouling - Advantages & Limitations of OTEC. TIDAL ENERGY – Principle of Tidal Power- Components of Tidal Power Plant (TPP)- Classification-single basin - double basin types – Limitations - Environmental impacts.	**8**
III	WIND ENERGY – Introduction - Basic principles of Wind Energy Conversion Systems (WECS), wind speed measurement- Classification of WECS - types of rotors. wind power equation - Betz limit. Electrical Power Output and Capacity Factor of WECS- Advantages and Disadvantages of WECS -site selection criteria.	**9**
IV	BIOMASS ENERGY – Introduction - Biomass fuels - Biomass conversion technologies – Energy through fermentation –pyrolysis, Gasification and Combustion - Factors affecting biogas generation-	**10**

	types of biogas plants – KVIC and Janata model - Biomass program in India. SMALL HYDRO POWER- Classification as micro, mini and small hydro projects - Basic concepts and types of turbines- selection considerations.	
V	EMERGING TECHNOLOGIES: Fuel Cell-principle of operation – classification- applications. Hydrogen energy - hydrogen production - hydrogen storage and utilization. ENERGY STORAGE: Need of energy storage; Different modes of energy storage, Flywheel storage, Pumped Hydroelectric energy storage, Compressed Air Energy Storage.	**7**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U31E	PROGRAMMING IN PYTHON	PEC	3	0	0	3	2022

i) **PREREQUISITE:** Nil.

ii) **COURSE OVERVIEW**: The objective of the course is to introduce Python programming and develop programming skills to manage the development of software systems. It covers data processing in Python and introduces Machine Learning and Artificial Intelligence- based applications and tools, Data Science and Data Visualization applications.

iii) **COURSE OUTCOMES**

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

CO 1	Explain the fundamental concepts in Python	Understand
CO 2	Illustrate uses of conditional statements and iterative statements in Python	Apply
CO 3	Develop programs by utilizing the modules Lists, Tuples, Sets and Dictionaries in Python	Apply
CO 4	Develop programs by using user defined functions	Apply
CO 5	Implement programs in Python to process data stored in files by utilizing the modules NumPy, Matplotlib,	Apply

iv) **SYLLABUS**

Basics of Python- Getting Started with Python Programming, Basic coding skills- Working with data types, Control statements, Selection structure, Iteration structure, Functions, Python data structures: Lists , Work with tuples, Sets, Dictionaries, Strings and lists, Object Oriented Programming: Design with classes, Exceptions, Visualization and File handling modules in python -NumPy, matplotlib, pandas.

v) **(a) TEXT BOOKS**

1) Kenneth A Lambert., Fundamentals of Python: First Programs, 2/e, Cengage Publishing, 2016 Rajaraman, V., Computer Basics and C Programming, Prentice-Hall India
2) David J. Pine, Introduction to Python for Science and Engineering, CRC Press, 2021

(b) REFERENCES

1) Wes McKinney, Python for Data Analysis, 2/e, Shroff / O'Reilly Publishers, 2017
2) Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 2/e, Schroff, 2016
3) Michael Urban and Joel Murach, Python Programming, Shroff/Murach, 2016
4) David M.Baezly, Python Essential Reference. Addison-Wesley Professional; 4/e, 2009.Charles Severance. Python for Informatics: Exploring Information.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Getting Started with Python Programming - Running code in the interactive shell, Editing, Saving, and Running a script. Using editors - IDLE, Jupyter. Basic coding skills - Working with data types, Numeric data types and Character sets, Keywords, Variables and Assignment statement, Operators, Expressions, Working with numeric data, Type conversions, Comments in the program. Input, Processing, and Output. Formatting output. How Python works. Detecting and correcting syntax errors. Using built in functions and modules in math module.	**8**
II	Building Python Programs: Control statements using break, continue and pass. Selection structure, Iteration structure Functions: Arguments and return values, Variable scopes and parameter passing, named arguments, Main function, Working with recursion, Lambda functions.	**8**
III	Python data structures: Lists - Basic List Operations and Methods, List of lists, Slicing, Searching and sorting list. Work with tuples, Sets, Dictionaries – Dictionary Methods, adding and removing keys, accessing and replacing values, traversing dictionaries. Strings and lists — String traversal and comparison with examples.	**9**
IV	Object Oriented Programming: Design with classes - Objects and Classes, Methods, Instance Variables, Constructor, Accessors and Mutators. Structuring classes with Inheritance and Polymorphism. Abstract Classes. Exceptions - Handle a single exception, handle multiple exceptions.	**10**
V	Visualization and File handling: The os and sys modules. Introduction to file I/O - Reading and writing text files, Manipulating binary files. NumPy - Basics, Creating arrays, Arithmetic, Slicing, Matrix Operations, Random numbers. Plotting and visualization.	**7**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U31F	OPERATING SYSTEMS	PEC	3	0	0	3	2022

i) PRE-REQUISITE: EL2U20B Data Structures, ES0U10E Programming in C

ii) COURSE OVERVIEW: The goal of this course is to introduce the concepts of memory management, device management, process management, file management, security and protection mechanisms available in an operating system. The course helps the learner to understand the fundamentals about any operating system design so that they can extend the features of the operating system to detect and solve many problems occurring in the operating system and to manage the computer resources appropriately.

iii) COURSE OUTCOMES

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

CO 1	Explain the relevance, structure and functions of Operating Systems in computing devices.	Understand
CO 2	Illustrate the concepts of process management and process scheduling mechanisms employed in Operating Systems.	Understand
CO 3	Explain process synchronization in Operating Systems and illustrate process synchronization mechanisms using Mutex Locks, Semaphores and Monitors	Understand
CO 4	Explain any one method for detection, prevention, avoidance and recovery for managing deadlocks in Operating Systems	Understand
CO 5	Explain the memory management algorithms in Operating Systems.	Understand
CO 6	Explain the security aspects and algorithms for file and storage management in Operating Systems.	Understand

iv) SYLLABUS

Operating system overview – Operations, Functions, Service – System calls, Types – Operating System structure.

Processes - Process states, Process control block, threads, scheduling, Operations on processes. Process Scheduling. Process synchronization- Race conditions. Synchronization problems.

Memory Management: Concept of address spaces. Segmentation, Paging. Virtual memory.

File System: File concept, File-system implementation, Directory implementation. Allocation methods.

v) (a) TEXT BOOKS

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, ' Operating System Concepts' 9th Edition, Wiley India 2013.
2. Andrew S Tanenbaum, Herbert Bos “Modern Operating Systems”, 4th Edition, Pearson India, 2016.
3. William Stallings, “Operating systems: Internals and Design Principles”, 7th Edition, Pearson Education India, 2013.

(b) REFERENCES

1. Garry Nutt, Nabendu Chaki, Sarmistha Neogy, "Operating Systems", 3rd Edition Pearson Education, 2016.
2. D.M.Dhamdhere, "Operating Systems", 2nd Edition, Tata McGraw Hill, 2011.
3. Sibsankar Haldar, Alex A Aravind, "Operating Systems", Pearson Education,2010.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction: Operating system overview – Operations, Functions, Service – System calls, Types – Operating System structure - Simple structure, Layered approach, Microkernel, Modules – System boot process.	**6**
II	Processes - Process states, Process control block, threads, scheduling, Operations on processes - process creation and termination – Inter-process communication - shared memory systems, Message passing systems. Process Scheduling – Basic concepts- Scheduling criteria -scheduling algorithms- First come First Served, Shortest Job First, Priority scheduling, Round Robin scheduling	**10**
III	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. Deadlocks: Necessary conditions, Resource allocation graphs, Deadlock prevention, Deadlock avoidance – Banker's algorithms, Deadlock detection, Recovery from deadlock.	**12**
IV	Memory Management: Concept of address spaces, Swapping, Contiguous memory allocation, fixed and variable partitions, Segmentation, Paging. Virtual memory, Demand paging, Page replacement algorithms.	**8**
V	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.	**9**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U31G	FOUNDATIONS OF MACHINE LEARNING	PEC	3	0	0	3	2022

i) PRE-REQUISITE: (Introduction to Signals & Systems) or equivalent

ii) COURSE OVERVIEW: The main goal of this course is to equip the students with a machine learning mindset for successful practical implementations, in particular: understand, analyze and design an approach to work with a data science or electrical engineering problem.

iii) COURSE OUTCOMES

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

CO 1	Identify relevant real-world problems as instances of canonical machine learning problems.	Understand
CO 2	Design and implement effective strategies for data pre-processing.	Understand
CO 3	Explain and utilize concepts of machine learning for electrical engineering	Understand
CO 4	Make connections between different fields of machine learning.	Understand
CO 5	General level of competency in critical questioning and analysis.	Apply

iv) SYLLABUS

Introduction-applications, probability theory – random - variables, distributions, mean-variance, marginalization, independence, condition and Bayes rule, Algorithm-Naïve bayes, nearest neighbour estimators, simple classifier, perceptron, k-means, Density Estimation
Optimization-Convex sets, convex functions, Convex minimization, constrained optimization, stochastic optimization, non-convex minimization. Kernels and Function spaces-Basics-examples, Kernels-Feature maps, Linear models-Support vector classification - regularised risk minimization view point, specialised algorithms for training SVMs. Extensions-v-trick, squared hinge loss, ramp loss. Support vector regression-general loss function and v-trick.Margins and probability. Classification-Multiclass, multilabel, ordinal regression and ranking. Large margin classifiers-margin, penalised margin, non-convex losses, Applications, Optmizations -column generation, bundle methods, over relaxation in the dual. CRF and structured large margin models-loss functions, dual connections, optimization.

v) (a) TEXT BOOKS

1) Christopher Bishop, Pattern Recognition and Machine Learning, First Edition, Springer publications, 2006.
2) Alex Smola and S.V.N. Vishwanathan, Introduction to machine learning, Cambridge University Press,2008.

(b) REFERENCE BOOKS

1) Kevin P. Murphy. Probabilistic Machine Learning: An introduction. MIT Press, 2022.
2) Bernhard Scholkopf and Alexander J. Smola. Learning with Kernels: Support Vector Machines, Regularization, Optimization, and Beyond. MIT Press, Cambridge, MA, USA, 2001.
3) Shai Shalev-Shwartz and Shai Ben-David. Understanding Machine Learning: From Theory to Algorithms. Cambridge University Press, New York, NY, USA, 2014.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction**-applications, probability theory – random - variables, distributions, mean - variance, marginalisation, independence, condition and Bayes rule, Algorithm-Naïve bayes, nearest neighbour estimators, simple classifier, perceptron, k-means. Density Estimation-limit theorem, parzen windows, estimation and sampling.	**9**
II	**Optimization**-Convex sets, convex functions, subgradients, convex functions with Lipschitz continuous gradient, Fenchel duality, Bregan divergence, Convex minimization, constrained optimization, stochastic optimization, non convex minimization.	**9**
III	**Kernels and Function spaces** – Basics - examples, Kernels-Feature maps, Kernel trick, examples, Algorithm-kernel perceptron, trivial classifier, kernel principal component analysis, reproducing kernel Hilbert spaces-hilbert spaces, theoretical properties, regularisation, Banach spaces-norms and convex sets.	**10**
IV	**Linear models**-Support vector classification-regularised risk minimization viewpoint, exponential family interpretation, specialised algorithms for training SVMs. Extensions-v trick, squared hinge loss, ramp loss. Support vector regression-general loss function and v-trick. Margins and probability.	**8**
V	**Classification**-Multiclass, multilabel, ordinal regression and ranking. Large margin classifiers-margin, penalised margin, non-convex losses, Applications, Optmizations - column generation, bundle methods, over relaxation in the dual. CRF and structured large margin models-loss functions, dual connections, optimization.	**9**
	Total hours (Approx.)	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U31H	WIRELESS SENSOR NETWORKS	PEC	3	0	0	3	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW: This course provides a comprehensive understanding of wireless sensor networks, covering fundamentals of wireless communication technology, ad-hoc/sensor network basics, MAC and routing protocols, and QoS & energy management. Students will explore wireless LANs, PANs, WANs, and MANs, along with issues, advantages, and challenges in sensor networks.

iii) COURSE OUTCOMES

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

CO 1	Explain the fundamentals of wireless sensor networks and its application in critical real time scenarios.	Understand
CO 2	Explain the unique constraints, challenges, and advantages associated with ad-hoc and sensor networks.	Understand
CO 3	Classify MAC protocols for ad-hoc and sensor networks and explain their applications in wireless sensor networks.	Understand
CO 4	Summarize various routing protocols and the challenges and requirements in designing routing protocols for wireless sensor networks.	Understand
CO 5	Explain and classify different energy management schemes.	Understand

iv) SYLLABUS

Introduction – Fundamentals of wireless communication technology – Electromagnetic spectrum radio propagation, characteristics, modulation of wireless channels.

Introduction to adhoc/sensor networks – Key definitions of adhoc/ sensor networks, driving applications, issues in adhoc wireless networks, sensor network architecture, data dissemination and gathering.

MAC Protocols – Issues in designing MAC protocols for adhoc wireless networks – design goals, classification of MAC protocols – MAC protocols for sensor network.

Routing Protocols – Issues in designing a routing protocol – classification of routing protocols – table-driven, on-demand, hybrid, flooding, hierarchical, and power aware routing protocols.

QoS and Energy Management – Issues and Challenges in providing QoS – classifications, MAC.

v) (a) TEXT BOOKS

1. Siva Ram Murthy, and B. S. Manoj, AdHoc Wireless networks, Pearson Education - 2008.

(b) Reference Books

1. Feng Zhao and Leonides Guibas, "Wireless sensor networks ", Elsevier publication - 2004.
2. Jochen Schiller, "Mobile Communications", Pearson Education, 2nd Edition, 2003.
3. William Stallings, "Wireless Communications and Networks ", Pearson Education – 2004.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction: Fundamentals of wireless communication technology, the electromagnetic spectrum radio propagation, characteristics of wireless channels, modulation techniques, multiple access techniques, wireless LANs, PANs, WANs, and MANs, Wireless Internet.	**9**
II	Introduction to adhoc/sensor networks: Key definitions of adhoc/ sensor networks, unique constraints and challenges, advantages of ad-hoc/sensor network, driving applications, issues in adhoc wireless networks, issues in design of sensor network, sensor network architecture, data dissemination and gathering.	**9**
III	MAC Protocols: Issues in designing MAC protocols for adhoc wireless networks, design goals, classification of MAC protocols, MAC protocols for sensor network, location discovery, quality, other issues, S-MAC, IEEE 802.15.4.	**10**
IV	Routing Protocols: Issues in designing a routing protocol, classification of routing protocols, table-driven, on-demand, hybrid, flooding, hierarchical, and power aware routing protocols.	**8**
V	QoS and Energy Management: Issues and Challenges in providing QoS, classifications, MAC, network layer solutions, QoS frameworks, need for energy management, classification, battery, transmission power, and system power management schemes.	**9**
	Total hours (Approx.)	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
HS0U30B	MANAGEMENT FOR ENGINEERS	HSC	3	0	0	3	2020

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW: This course aims to enable the student learn the basic concepts and functions of management and its role in the performance of an organization and to understand various decision-making approaches available for managers to achieve excellence.

iii) COURSE OUTCOMES

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

CO 1	Explain the characteristics of management in the contemporary context	Understand
CO 2	Summarize the functions of management	Understand
CO 3	Infer the decision-making process and productivity analysis	Apply
CO 4	Demonstrate project management technique and develop a project schedule	Apply
CO 5	Explain the functional areas of management and the concept of entrepreneurship	Understand

iv) SYLLABUS

Introduction to management theory- Characteristic of Management, System approaches to Management, Task and Responsibilities of a professional Manager.

Management and organization-Management Process, Planning types, Principles of Organization, Organization Structures.

Productivity and decision making- Concept of productivity and its measurement; Decision making process; Decision trees; Models of decision making.

Project management- Network construction, CPM and PERT Networks, Scheduling computations, PERT time estimates, Probability of completion of project.

Functional areas of management- Operations management, Human resources management, Marketing management, Financial management, Entrepreneurship, Business plans, Corporate social responsibility, Patents and Intellectual property rights.

v) (a) TEXT BOOKS

1. H. Koontz, and H. Weihrich, Essentials of Management: An International Perspective. 10th ed., McGraw-Hill, 2015.
2. P. Kotler, K. L. Keller, A. Koshy, and M. Jha, Marketing Management: A South Asian Perspective. 15th ed., Pearson, 2016.
3. R. D. Hisrich, and M. P. Peters, Entrepreneurship: Strategy, Developing, and Managing a New Enterprise, 11th ed., McGraw-Hill Education, 2020.
4. M. Y. Khan, and P. K. Jain, Financial Management, Tata-McGraw Hill, 2020.

(b) REFERENCE

1. R. B. Chase, Ravi Shankar and F. R. Jacobs, Operations and Supply Chain Management, 15th ed. McGraw Hill Education (India), 2018.
2. P C Tripathi and P N Reddy, Principles of management, TMH, 5th edition, 2012.
3. K. Ashwathappa, 'Human Resources and Personnel Management', TMH, 7th edition, 2011.
4. D. J. Sumanth, Productivity Engineering and Management, McGraw-Hill Education, 2019.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to management theory, Management Defined, Characteristic of Management, Management as an art-profession, System approaches to Management, Task and Responsibilities of a professional Manager, Levels of Manager and Skill required.	**8**
II	Management Process, Planning types, Mission, Goals, Strategy, Programs, Procedures, Organizing, Principles of Organization, Delegation, Span of Control, Organization Structures, Directing, Leadership, Motivation, Controlling.	**8**
III	Concept of productivity and its measurement; Competitiveness; Decision making process; decision making under certainty, risk and uncertainty; Decision trees; Models of decision making.	**9**
IV	Project Management, Network construction, Arrow diagram, Redundancy. CPM and PERT Networks, Scheduling computations, PERT time estimates, Probability of completion of project, Introduction to crashing.	**10**
V	Introduction to functional areas of management, Operations management, Human resources management, Marketing management, financial management, Entrepreneurship, Business plans, Corporate social responsibility, Patents and Intellectual property rights.	**10**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
NC0U30A	DISASTER MANAGEMENT	MNC	2	0	0	--	2020

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

The goal of this course is to expose the students to the fundamental concepts of hazards and disaster management. The course details the various phases of disaster risk management and the measures to reduce disaster risks.

iii) COURSE OUTCOMES

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

CO1	Explain the fundamental concepts and terminology related to disaster management cycle	Understand
CO2	Explain hazard and vulnerability types and disaster risk assessment	Understand
CO3	Describe the process of risk assessment and appropriate methodologies to assess risk	Understand
CO4	Explain the core elements and phases of disaster risk management and measures to reduce disaster risks across sector and community	Apply
CO5	Discuss the factors that determine the nature of disaster response and the various disaster response actions	Understand
CO6	Explain the legislations and best practices for disaster management and risk reduction at national and international level	Understand

iv) SYLLABUS

Introduction- Systems of Earth, Key concepts and terminology in disaster risk reduction and management

Hazard types, Vulnerability types and their assessment, Disaster risk assessment

Disaster risk management- Phases of disaster risk management, Measures for disaster risk reduction- prevention, mitigation, preparedness, Disaster response, Relief

Participatory stakeholder engagement, Disaster communication, Capacity building

Common disaster types in India, Legislations in India on Disaster Management, National Disaster Management Policy, Institutional arrangements for disaster management in India, The Sendai Framework for Disaster risk reduction.

v) (a) TEXT BOOKS

1) Coppola, D.P., *Introduction to International Disaster Management*, Elsevier Science (B/H), London, 2020.
2) Srivastava, H.N., Gupta, G.D., *Management of Natural Disasters in developing countries*, Daya Publishers, Delhi, 2007.
3) Subramanian, R., *Disaster Management*, Vikas Publishing House, 2018.
4) Sulphey, M.M., Disaster *Management*, PHI Learning, 2016.

(b) REFERENCES

1) NDMA, *National Policy on Disaster Management*, Ministry of Home Affairs, Government of India, 2009.
2) National Disaster Management Division, *Disaster Management in India - A Status Report*, Ministry of Home Affairs, Government of India, New Delhi, 2004.
3) *National Disaster Management Plan*, NDMA, Ministry of Home Affairs, Government of India, 2019.
4) *Disaster Management Training Manual*, UNDP, 2016.
5) United Nations Office for Disaster Risk Reduction, *Sendai Framework for Disaster Risk Reduction 2015-2030*, 2015.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction about various systems of earth, Lithosphere- composition, rocks, soils; Atmosphere- layers, ozone layer, greenhouse effect. Weather, cyclones, atmospheric circulations, Indian monsoon; Hydrosphere- oceans, inland water bodies; Biosphere. Definition and meaning of key terms in Disaster risk reduction and Management – disaster, hazard, exposure, vulnerability, risk, risk assessment, risk mapping, capacity, resilience, disaster risk reduction, disaster risk management, early warning systems, disaster preparedness, disaster prevention, disaster mitigation, disaster response, damage assessment, crisis counselling, needs assessment.	**6**
II	Various hazard types, hazard mapping; Different types of vulnerability types and their assessment- Physical, social, economic and environmental vulnerability. Core elements of disaster risk assessment. Components of a comprehensive disaster preparedness strategy approaches, procedures. Different disaster response actions.	**6**
III	Introduction to disaster risk management, core elements of disaster risk management. Phases of disaster risk management, Measures for disaster risk reduction. Measures for disaster prevention, mitigation, and preparedness. Disaster response - objectives, requirements. Disaster response planning; types of responses. Disaster relief, International relief organizations.	**7**
IV	Participatory stakeholder engagement, Importance of disaster communication, Disaster communication- methods, barriers, Crisis counselling. Introduction to capacity building, Concept- Structural measures, Non-structural measures. Introduction to Capacity assessment, Capacity assessment- Strengthening, Capacity for reducing risk.	**5**
V	Introduction - common disaster types in India. Common disaster legislations in India on disaster management. National disaster management policy, Institutional arrangements for disaster management in India. The Sendai Framework for Disaster risk reduction and targets- priorities for action, guiding principles.	**6**
	Total hours	**30**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U38A	ELECTRICAL MACHINES LAB	PCC	0	0	3	2	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

Objective of the course is to impart practical knowledge to the students by exposing them to hands-on experience of testing DC and AC machines and to validate the results. The course also intends to prepare the students to analyse the performance of a given machine by adopting suitable tests.

iii) COURSE OUTCOMES

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

CO1	Apply load tests on the given DC motor/generator to obtain performance characteristics.	Apply
CO2	Apply OC and SC tests on the given transformer to obtain its equivalent circuit.	Apply
CO3	Apply load tests on the given Induction Motor to obtain its performance characteristics.	Apply
CO4	Apply no load and blocked rotor tests on the given Induction Motor to develop the circle diagram and equivalent circuit.	Apply
CO5	Apply direct load test and mmf method to find the regulation of the given Alternator.	Apply

iv) SYLLABUS

- Familiarization of meters, instruments and safety measures adopted in the laboratory; Study of starters of three phase Induction Motors
- Load Test on a DC Series Motor
- Load Test on a DC Shunt Motor
- OCC of a DC Shunt Generator
- Load Characteristics of a DC Shunt Generator
- OC and SC Tests on a single phase transformer
- OC and SC Tests on a three phase transformer
- Load Test on a three phase slip ring Induction Motor
- Load Test on a three phase squirrel cage Induction Motor
- No Load and Blocked Rotor tests on a three phase squirrel cage Induction Motor
- Starting of three phase squirrel cage Induction Motor using Y-Δ Starter
- No Load and Blocked Rotor Tests on a single phase capacitor start Induction Motor
- Load Test on a single phase capacitor start-run Induction Motor
- Regulation of a three phase Alternator by direct loading
- Regulation of a three phase Alternator by EMF method

v) REFERENCES

1) Bimbra P S, *Electric Machines*, Khanna Publishers, 2nd Edition, 2017.
2) D. P. Kothari, I. J. Nagrath, *Electric Machines*, Tata McGraw Hill, 5th Edition.
3) Say M G, *The Performance and Design of AC Machines*, CBS Publishers, New Delhi, 3rd Edition, 2002.
4) Langsdorf M. N., *Theory of Alternating Current Machinery*, Tata McGraw Hill, 2nd revised Edition, 2001.

vi) COURSE PLAN

Expt. No.	List of exercises/experiments	No. of hours
I	a. Familiarization of meters and instruments used in Electrical Machines Lab b. Study of safety measures to be taken while performing experiments in the lab c. Study of starters of three phase Induction Motors	**3**
II	**Load Test on a DC Series Motor** a. Plot the performance characteristics b. Plot the electrical and mechanical characteristics	**3**
III	**Load Test on a DC Shunt Motor** a. Plot the performance characteristics b. Plot the electrical and mechanical characteristics	**3**
IV	**OCC of a DC Shunt Generator** a. Plot the OCC at rated speed b. Plot the OCC at a speed other than the rated c. Determine critical resistance and critical speed d. Determine the additional resistance required to just excite the machine	**3**
V	**Load Characteristics of a DC Shunt Generator** Plot the internal and external characteristics	**3**
VI	**OC and SC Tests on a single phase transformer** a. Predetermination of efficiency b. Predetermination of regulation c. Obtain the equivalent circuit	**3**
VII	**OC and SC Tests on a three phase transformer** a. Predetermination of efficiency b. Predetermination of regulation c. Obtain the equivalent circuit	**3**
VIII	**Load test on a three-phase slip ring Induction Motor** a. Start the motor using autotransformer or rotor resistance starter and perform load test b. Plot the performance characteristics	**3**
IX	**Load test on a three-phase squirrel cage Induction Motor** a. Start the motor using autotransformer or rotor resistance starter and perform load test b. Plot the performance characteristics	**3**
X	**No load and block rotor test on a three-phase squirrel cage Induction Motor** a. Predetermination of performance parameters from circle diagram b. Deduction of equivalent circuit	**3**
XI	**Starting of a three-phase squirrel cage Induction Motor using Y-Δ Starter** a. Start the motor using Y-Δ Starter and perform load test	**3**

	b. Plot the performance characteristics	
XII	**No Load and Blocked Rotor Tests on a single phase capacitor start Induction Motor** Develop the equivalent circuit of the motor	**3**
XIII	**Load Test on a single phase capacitor start-run Induction Motor** a. Perform load test on the motor b. Plot the performance characteristics of the motor	**3**
XIV	**Regulation of a three phase Alternator by direct loading** a. Determine the regulation of three phase alternator b. Plot the regulation curve	**3**
XV	**Regulation of a three phase Alternator by emf method** Predetermine the regulation of alternator by emf method at 0.8pf lag, upf and 0.8pf lead.	**3**
	Total Hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

(a)	Attendance	:	15 marks
(b)	Continuous Assessment	:	30 marks
(c)	Internal Test	:	30 marks
	Total	**:**	**75 marks**

viii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- **One test of 30 marks**
- Duration – **2 ½ hours**

ix) END SEMESTER EXAMINATION PATTERN

(a)	Preliminary work	:	15 marks
(b)	Implementing the work/Conducting the experiment	:	20 marks
(c)	Performance, result and inference (usage of equipment and troubleshooting):	:	15 marks
(d)	Viva voce	:	20 marks
(e)	Record	:	5 Marks
	Total	**:**	**75 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U38B	DATABASE MANAGEMENT SYSTEM LAB	PCC	0	0	3	2	2022

i) PRE-REQUISITE: EL2U30A - Database Management Systems

ii) COURSE OVERVIEW:

The Database Management Systems course aims to provide students with foundational knowledge of database management systems. It empowers them to design and execute database applications utilizing these principles. The course offers hands-on experience in areas such as database creation, crafting SQL queries, transaction processing, and operations involving NoSQL & MongoDB. Students will gain the ability to independently create, oversee, and administer databases, as well as develop essential tools for database design and implementation. Moreover, the course fosters an understanding of emerging technologies tailored for handling Big Data."

iii) COURSE OUTCOMES

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

CO 1	Develop database schema for a given real-world problem-domain using standard design and modelling approaches.	Apply
CO 2	Construct queries using SQL for database creation, interaction, modification, and updation.	Apply
CO 3	Model and implement triggers and cursors.	Apply
CO 4	Develop procedures, functions, and control structures using PL/SQL**.**	Apply
CO 5	Experiment with CRUD operations in NoSQL Databases.	Apply
CO 6	Develop database applications using front-end tools and back-end DBMS.	Apply

iv) LIST OF EXPERIMENTS

- Design a database schema for an application with ER diagram from a problem description**
- Creation, modification, configuration, and deletion of databases using UI and SQL Commands **.
- Creation of database schema - DDL (create tables, set constraints, enforce relationships, create indices, delete and modify tables). Export ER diagram from the database and verify relationships** (with the ER diagram designed in step 1).
- Database initialization - Data insert, Data import to a database (bulk import using UI and SQL Commands)**.
- Practice SQL commands for DML (insertion, updating, altering, deletion of data, and viewing/querying records based on condition in databases)**.
- Implementation of built-in functions in RDBMS**.
- Implementation of various aggregate functions in SQL**.
- Implementation of Order By, Group By & Having clause **.
- Implementation of set operators nested queries, and join queries **.
- Implementation of queries using temp tables.
- Practice of SQL TCL commands like Rollback, Commit, Savepoint **.

- Practice of SQL DCL commands for granting and revoking user privileges **.
- Practice of SQL commands for creation of views and assertions ** .
- Implementation of various control structures like IF-THEN, IF-THEN-ELSE, IF-THENELSEIF, CASE, WHILE using PL/SQL **.
- Creation of Procedures, Triggers and Functions**.
- Creation of Packages **.
- Creation of Cursors **.
- Creation of PL/SQL blocks for exception handling **.
- Database backup and restore using commands.
- Query analysis using Query Plan/Show Plan.
- Familiarization of NoSQL Databases and CRUD operations**.
- Design a database application using any front end tool for any problem selected. The application constructed should have five or more tables**.

** mandatory

v) a) TEXT BOOKS

1. Elmasri R. and S. Navathe, Database Systems: Models, Languages, Design and Application Programming, Pearson Education, 2013.
2. Sliberschatz A., H. F. Korth and S. Sudarshan, Database System Concepts, 6/e, McGraw Hill, 2011.

b) REFERENCES

1. Adam Fowler, NoSQL for Dummies, John Wiley & Sons, 2015
2. NoSQL Data Models: Trends and Challenges (Computer Engineering: Databases and Big Data), Wiley, 2018.

vi) COURSE PLAN

Expt. No.	List of exercises/experiments	No. of hours
I	Design a database schema for an application with ER diagram from a problem description	3
II	Creation, modification, configuration, and deletion of databases using UI and SQL Commands	3
III	Creation of database schema - DDL (create tables, set constraints, enforce relationships, create indices, delete and modify tables). Export ER diagram from the database and verify relationships (with the ER diagram designed in step 1).	3
IV	• Database initialization - Data insert, Data import to a database (bulk import using UI and SQL Commands) • Practice SQL commands for DML (insertion, updating, altering, deletion of data, and viewing/querying records based on condition in databases)	3
V	• Implementation of built-in functions in RDBMS • Implementation of various aggregate functions in SQL	3
VI	• Implementation of Order By, Group By & Having clause • Implementation of set operators nested queries, and join queries.	3
VII	• Implementation of queries using temp tables. • Practice of SQL TCL commands like Rollback, Commit, Savepoint	3

VIII	**i)** Practice of SQL DCL commands for granting and revoking user privileges **ii)** Practice of SQL commands for creation of views and assertions	**3**
IX	Implementation of various control structures like IF-THEN, IF-THEN-ELSE, IF-THEN ELSIF, CASE, WHILE using PL/SQL	**3**
X	• Creation of Procedures, Triggers and Functions	**3**
XI	• Creation of Packages • Creation of Cursors	**3**
XII	• Creation of PL/SQL blocks for exception handling • Database backup and restore using commands.	**3**
XIII	Query analysis using Query Plan/Show Plan.	**3**
XIV	Familiarization of NoSQL Databases and CRUD operations.	**3**
XV	Design a database application using any front-end tool for any problem selected. The application constructed should have five or more tables.	**3**
	Total Hours	**45**

x) CONTINUOUS ASSESSMENT EVALUATION PATTERN

(a)	Attendance	:	15 marks
(b)	Continuous Assessment	:	30 marks
(c)	Internal Test	:	30 marks
	Total	**:**	**75 marks**

xi) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- **One test of 30 marks**
- Duration – **2 ½ hours**

xii) END SEMESTER EXAMINATION PATTERN

(a)	Preliminary work	:	2 marks
(b)	Algorithm	:	8 marks
(c)	Program with output	:	40 marks
(d)	Viva voce	:	20 marks
(e)	Record	:	5 Marks
	Total	**:**	**75 marks**

B.TECH MINORS

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL0M30I	ENERGY STORAGE DEVICES	VAC	3	1	0	4	2022

i) PRE-REQUISITE: Nil.

ii) COURSE OVERVIEW: This course is to expose the students to the fundamental concepts of energy storage systems used in different applications.

iii) COURSE OUTCOMES

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

CO1	Interpret the role of energy storage in power systems.	Understand
CO2	Classify thermal, kinetic and potential storage technologies and their applications.	Understand
CO3	Compare Electrochemical, Electrostatic and Electromagnetic storage technologies.	Understand
CO4	Apply energy storage technology in renewable energy integration.	Apply
CO5	Explain energy storage technology applications for smart grids.	Understand

iv) SYLLABUS

Introduction to energy storage in power systems- General considerations

Overview on Energy storage technologies - Thermal energy, Potential energy: Pumped hydro-Compressed Air, Kinetic energy: Mechanical- Flywheel, Power to Gas

Overview on Energy storage technologies- Batteries- Parameters, Fuel cells, Electrostatic energy Electromagnetic energy, Comparative analysis, Environmental impacts.

Energy storage and renewable power sources- Wave - Wind – Tidal – Hydroelectric - Solar thermal technologies and Photovoltaics, Storage role in isolated and integrated power systems with renewable power sources.Energy storage Applications - Smart grid, Smart house, Mobile storage system- Electric vehicles – Grid to Vehicle (G2V)-Vehicle to Grid (V2G), Battery SCADA, Hybrid energy storage systems.

v) (a) TEXT BOOKS

1) Osaka T., Datta M., “Energy Storage Systems in Electronics-New Trends in Electrochemical Technology”, CRC Press 2000.
2) Rand D.A.J., Moseley P.T., Garche J. and Parker C.D., “Valve regulated Lead–Acid Batteries”, Elesevier 2004.

(b) REFERENCES

1) Broussely M. and Pistoia G., "Industrial Applications of Batteries from Cars to Aerospace and Energy Storage", Elsevier, 2007
2) Nazri G. A. and Pistoia G., "Lithium Batteries – Science and Technology", Kluwer Academic Publishers, 2004
3) Larminie J., Dicks A. and Wiley-Blackwell, "Fuel Cell Systems Explained", 2nd Edition, Wiley Publications, 2013.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to energy storage in power systems:** Energy storage systems overview - Scope of energy storage, needs and opportunities in energy storage, comparison of storages and applications, Energy storage in the power and transportation sectors. Importance of energy storage systems in electric vehicles, Current electric vehicle market. Need and role of energy storage systems in power systems, General considerations, Energy and power balance in a storage unit.	**12**
II	**Overview on Energy storage technologies:** Thermal energy: General considerations - Storage media- Containment- Thermal energy storage in a power plant, Potential energy: Pumped Hydro-Compressed Air, Kinetic energy: Mechanical - Flywheel, Power to Gas - Hydrogen - Synthetic methane	**12**
III	**Overview on Energy storage technologies:** Electrochemical energy - Batteries- Battery parameters: C-rating -SoC- DoD- Specific Energy-Specific power (numerical examples), Fuel cells, Electrostatic energy (Super Capacitors), Electromagnetic energy (Super conducting Magnetic Energy Storage), Comparative analysis, Environmental impacts of different technologies.	**12**
IV	**Energy storage and renewable power sources:** Types of renewable energy sources: Wave - Wind – Tidal – Hydroelectric - Solar thermal technologies and Photovoltaics, Storage role in isolated power systems with renewable power sources, Storage role in an integrated power system with grid-connected renewable power sources.	**12**
V	**Energy storage Applications:** Smart grid, Smart microgrid, 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.	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL0M30J	SOLAR AND WIND ENERGY CONVERSION SYSTEMS	VAC	3	1	0	4	2022

i) PRE-REQUISITE: ES0U10D Basics of Electrical and Electronics Engineering, EL0M20F Energy Systems.

ii) COURSE OVERVIEW:

This course aims to impart the knowledge of renewable energy sources as sustainable development. The students will be familiarized with the major aspects of solar and wind energy conversion systems. This course also aims at providing the fundamental information in modelling the energy conversion systems.

iii) COURSE OUTCOMES

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

CO 1	Explain the basics of solar energy conversion systems.	Understand
CO 2	Explain the principle behind solar thermal systems and its applications.	Understand
CO 3	Apply the design aspects of solar photovoltaic systems in sizing its components.	Apply
CO 4	Explain the concepts involved in wind energy systems.	Understand
CO 5	Classify various Wind Energy Conversion and Wind Electric Generation Systems and discuss the issues with hybrid energy conversion systems.	Understand

iv) SYLLABUS

Solar Energy - Solar radiation – Solar Radiation on an Inclined/Tilted Surface.
Solar Thermal Systems – Solar Concentrators – Applications.
Solar photovoltaic systems - Characteristics - Types of solar cells - PV Module - Block diagram of SPV system – MPPT – Design of SPV - Modelling of SPV.
Wind Energy - Wind power and its sources - Modes of wind power generation.
Wind Energy Conversion Systems WECS – Principles - Classification of WECS - Wind Electric Generation Systems - Effects of Wind Speed and Grid Condition.

v) (a) TEXT BOOKS

1) Earnest J. and T. Wizelius, *Wind Power Plants and Project Development*, Prentice Hall of India, Learning Private Limited, 2nd edition, 2015.
2) Godfrey Boyle, *Renewable Energy: Power for a sustainable future*, Oxford University Press, 2012.
3) Rai. G.D, *Non-conventional Energy Sources*, Khanna publishers, 2011.
4) A.A.M. Saigh (Ed): *Solar Energy Engineering*, Academic Press, 1977.
5) G.N. Tiwari: Solar Energy-Fundamentals, Design, Modelling and Applications, Narosa Publishers,2002.

(b) REFERENCES

1) Gary, L. Johnson, *Wind Energy System*, Prentice Hall, 1985.
2) C. S. Solanki, *Solar Photovoltaics: Fundamentals Technologies and Applications*, Prentice-Hall of India Pvt. Limited, 3rd edition, 2015.
3) Rai. G.D, *Solar Energy Utilization*, Khanna Publishers, 1995.
4) Kastha D, Banerjee S and Bhadra S N, *Wind Electrical Systems*, Oxford University Press, New Delhi, 2005.
5) Rashid M.H., *Power Electronics Circuits, Devices and Applications*, 4th edition, Pearson Education, 2017.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction** - Basic Concept of Energy - Source of Solar Energy - Formation of the Atmosphere - Solar Spectrum. Solar Constant - Air Mass - Solar Time-Sun – Earth Angles - Solar Radiation - Instruments to Measure Solar Radiation - Pyrheliometer – Pyranometer - Sunshine Recorder -Solar Radiation on a Horizontal Surface - Extra-terrestrial Region - Terrestrial Region - Solar Radiation on an Inclined Surface - Conversion Factors - Total Solar Radiation on an Inclined/Tilted Surface - Monthly Average Daily Solar Radiation on Inclined Surfaces.	**12**
II	**Solar Thermal System** - Principle of Conversion of Solar Radiation into Heat, – Solar thermal collectors – General description and characteristics – Flat plate collectors – Heat transfer processes – Solar concentrators (parabolic trough, parabolic dish, Central Tower Collector) – performance evaluation. Applications - Solar heating system, Air conditioning and Refrigeration system, Pumping system, solar cooker, Solar Furnace, Solar Greenhouse -Design of solar water heater.	**11**
III	**Solar PV Systems** - Introduction - Fundamentals of Semiconductor and Solar Cells - Photovoltaic Effect - Solar Cell (Photovoltaic) Materials - Basic Parameters of the Solar Cell - Generation of Solar Cell (Photovoltaic) Materials-.Photovoltaic (PV) Module and PV Array - Single-Crystal Solar Cell Module, Thin-Film PV Modules, III-V Single Junction and Multijunction PV Modules - Emerging and New PV Systems - Packing Factor of the PV Module - Efficiency of the PV Module - Energy Balance Equations for PV Modules -Series and Parallel Combination of PV Modules - Effect of shadowing-Maximum Power Point Tracker (MPPT) using buck-boost converter. Solar PV Systems – stand-alone and grid connected - Design steps for a Stand-Alone system – Storage batteries and Ultra capacitors.	**13**
IV	**Wind Turbines** – Introduction - Origin of Winds - Nature of Winds – Classification of Wind Turbines - Wind Turbine Aerodynamics - Basic principles of wind energy extraction – Extraction of wind turbine power (Numerical problems) - Weibull distribution - Wind power generation curve-Betz's Law - Modes of wind power generation.	**12**

V	**Wind Energy Conversion Systems** – Introduction - Components of WECS - Fixed speed drive scheme - Variable speed drive scheme - Wind–Diesel Hybrid System – Induction generators - Doubly Fed Induction Generator (DFIG) - Squirrel Cage Induction Generator (SCIG) - Power converters in renewable energy system - AC-DC Converters, DC-DC Converters, DC-AC Converters (Block Diagram Only) - Effects of Wind Speed and Grid Condition (System Integration) - Environmental Aspects - Wind Energy Program in India.	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL0M30K	RASPBERRY PI-PLATFORM INTERFACE & PYTHON PROGRAMMING	VAC	3	1	0	4	2022

i) PRE-REQUISITE: - EE0M20E Hardware Interfacing using Arduino- C Platform

ii) COURSE OVERVIEW:

The Goal of this course is to expose the students to learn how the Raspberry Pi platform works in terms of the physical board and libraries and the IDE (Integrated Development Environment). The course will cover programming the Raspberry Pi using Python code and accessing the pins on the board via the software to control external devices.

iii) COURSE OUTCOMES

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

CO 1	Explain the composition of Pi Processor, its architecture, Raspberry Pi Vs Arduino and Raspberry Pi IoT	Understand
CO 2	Develop skills for writing Python programs for Raspberry Pi	Apply
CO 3	Illustrate the communication of devices with Raspberry Pi	Understand
CO 4	Summarize the networking in Raspberry Pi	Understand
CO 5	Explain the interfacing of devices with Raspberry Pi	Understand

iv) SYLLABUS

Introduction to Raspberry Pi and Linux, Raspberry Pi vs Arduino, Linux operating system Basics, Linux file system, Linux Graphic user interface. Basics of Python Programming-Python on Raspberry Pi, Basic debugging requirements: controllability and observability using UART communication. Communication of devices with Raspberry Pi-General purpose IO pins, Tkinter library. Networking socket interface- sockets, sending data, exemptions, server code, network libraries, web services, public APIs. Interfacing with Raspberry Pi - camera module, pi camera library, capturing images.

v) (a) TEXT BOOKS

1) Tim Cox, Raspberry Pi Cookbook for Python Programmers, Packt Publishing Limited, second edition, September 2016.
2) Alex Bradbury, Ben Everard, Learning Python with Raspberry Pi, John Wiley & Sons, 2014.
3) Simon Monk, Programming the Raspberry Pi, McGraw-Hill Education, second edition 2015

(b) REFERENCES

1) Herb Norbom, *Raspberry Pi Python Projects*, Createspace Independent Publishers, first edition 2017.
2) Colin Dow, Internet of Things Programming Projects: Build modern IoT solutions with the Raspberry Pi 3 and Python, Packt Publishing Limited, 2018.

3) Joe Grant, Raspberry Pi: A Comprehensive Beginner's Guide to Setup, Programming (Concepts and techniques) and Developing Cool Raspberry Pi Projects, Independently Published, 2019.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Raspberry Pi and Linux - Pi Processor, Raspberry Pi Vs Arduino, Raspberry Pi IoT and Raspberry Pi set up, Raspberry Pi configuration, Linux operating system Basics, Linux file system, Linux Graphic user interface.	**8**
II	Basics of Python Programming-Introduction, Python on Raspberry Pi, Python Expressions, strings, functions, function arguments, lists, list methods, control flow	**14**
III	Communication of devices with Raspberry Pi-General purpose IO pins, protocol pins, GPIO Access, Graphic user interface, Tkinter library, interaction, Network programs, secure shell, SSH cline/server, Internet protocols, IP addresses, domain names	**14**
IV	Networking socket interface-Introduction, sockets, sending data, exemptions, server code, live server, internet control, Python client demo, Python server demo, network libraries, web services, public APIs	**14**
V	Interfacing with Raspberry Pi-Introduction, camera module, pi camera library, capturing images, PWM on RPI, servo control	**10**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL0M30L	ENERGY EFFICIENCY IN BUILDINGS	VAC	4	0	0	4	2020

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

Goal of this course is to expose the students to the fundamental concepts of energy efficient design of buildings such as lighting, heating, ventilation etc. This course also intends to make students aware of ECBC, LEED, GRIHA etc.

iii) COURSE OUTCOMES

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

CO 1	Explain building services and factors for optimum design of energy efficient buildings.	Understand
CO 2	Describe the concepts of energy efficient heating and ventilation.	Understand
CO 3	Illustrate the various energy efficient lighting techniques employed in buildings.	Understand
CO 4	Explain the energy efficiency in pumps, blowers, fans, air conditioning etc.	Understand
CO 5	Identify the various energy efficient design techniques in buildings	Apply

iv) SYLLABUS

Building Services- Climate adapted and climate rejecting buildings – Bioclimatic zones -Heat Transfer - Thermal Storage- Environmental Factors, Site Planning and Development

Energy efficient heating and ventilation– Terminology – Requirements Thermal performance of Building sections- Natural Ventilation – Purpose of ventilation- Design for Natural Ventilation

Energy efficient lighting-Day Lighting- Lighting principles and fundamentals- Lighting control for day lighted buildings – Switching controls- Power Adjustment Factors

Energy efficiency in pumps, blowers, fans, compressed air system, refrigeration and air conditioning system-Cooling towers- DG sets-Energy efficient HVAC systems

Energy Efficient Design of Buildings - Green Buildings - Energy efficient materials for buildings – Design - Operational energy reduction and net zero building

Energy codes ECBC (ECBC 2007) requirement, Concepts of OTTV etc, Green Performance rating, requirements of LEED, GRIHA etc.

v) (a) TEXT BOOKS

1) Givoni B., Passive and Low Energy Cooling of Buildings, John Wiley & Sons, Inc, 1994.

2) Callaghn P.W., Design and Management for Energy Conservation, Pergamon Press, John Wiley and Sons Inc, Oxford, 2001.

3) Energy Conservation Building Code, Bureau of Energy Efficiency, New Delhi, Bureau of Energy Efficiency Publications-Rating System, TERI Publications- GRIHA Rating System.

(b) REFERENCES

1) Part 1 to 4 SP: 41,1987, *Handbook on Functional Requirements of Buildings*, Bureau of Indian Standards Publication, 1st reprint, 1995.

2) Majumdar M., *Energy - Efficient Buildings in India*, Tata Energy Research Institute, Ministry of Non-Conventional Energy Sources, 2002.

3) Moore, F., *Environmental Control System*, McGraw Hill Inc. 2002

4) Tyagi, A. K., *Handbook on Energy Audits and Management*, Tata Energy Research Institute, 2000.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction- Building Services- Climate adapted and climate rejecting buildings – Heat Transfer – Measuring Conduction – Thermal Storage – Measurement of Radiation –Greenhouse Effect – Convection – Measuring latent and sensible heat – Thermal Comfort – Microclimate, Environmental Factors, Site Planning and Development – Temperature – Humidity – Wind – Steady and Periodic Heat Transfer-Optimum Site Locations.	**12**
II	Energy efficient heating and ventilation- Hourly Solar radiation – Heat insulation – Terminology – Requirements – Heat transmission through building sections – Thermal performance of Building sections – Orientation of buildings – Building characteristics for various climates – Thermal Design of buildings – Influence of Design Parameters – Mechanical controls – Examples. Natural Ventilation – Purpose of ventilation – Minimum standards for ventilation – Ventilation Design – Mechanisms- Energy Conservation in Ventilating systems – Design for Natural Ventilation.	**12**
III	Energy efficient lighting- Day Lighting- Lighting principles and fundamentals- Daylight Factor - Daylight Analysis - Daylight and Shading Devices- Materials, components and details – Insulation – Optical materials – Radiant Barriers – Glazing materials – Glazing Spectral Response-Electric Lighting – Light Distribution – Electric Lighting control for day lighted buildings – Switching controls – Coefficient of utilization – Electric Task Lighting – Electric Light Zones – Power Adjustment Factors.	**12**
IV	Energy efficiency in pumps, blowers, fans, compressed air system, refrigeration and air conditioning system-Cooling towers- DG sets-Energy efficient HVAC systems	**12**
V	Energy Efficient Design of Buildings-Green Buildings-Design-Operational energy reduction and net zero building, Optimization for design of building for energy efficiency and example of optimization through use of Evolutionary genetic algorithm- Effects of trees and microclimatic modification through greening, Use of Building Integrated Photo Voltaic (BIPV) and other renewable energy in buildings, basic concepts and efficiency. Energy codes ECBC (ECBC 2007) requirement, Concepts of OTTV etc, Green Performance rating, requirements of LEED, GRIHA etc.	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

SEMESTER VI

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U30D	POWER ELECTRONICS AND DRIVES	PCC	3	1	0	4	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

The goal of this course is to expose the students to the fundamental concepts of Power Electronic Devices. It also includes the circuit analysis of various power converter circuits. The course also provides an insight on the basic concepts of AC & DC drives.

iii) COURSE OUTCOMES

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

CO 1	Explain the operation of modern power semiconductor devices and its characteristics.	Understand
CO 2	Identify the working of controlled rectifiers.	Apply
CO 3	Explain the working of AC voltage controllers, inverters and PWM techniques.	Understand
CO 4	Identify the performance of different DC-DC converters.	Apply
CO 5	Explain basic drive schemes for AC and DC motors.	Understand

iv) SYLLABUS

Structure and principle of operation of power devices: Power diode, Power MOSFET & IGBT – switching characteristics - comparison, SiC, GaN.

SCR- Structure, Static characteristics & Switching (turn-on & turn-off) characteristics - di/dt & dv/dt protection – Turn-on methods of SCR - Two transistor analogy.

Gate drive circuit: Triggering circuit-gate drive circuit-Isolation.

AC-DC converters: Single phase half wave controlled, fully controlled, semi controlled ac-dc converter.

Three Phase AC-DC converters: Three phase half wave Controlled, fully controlled, semi controlled ac-dc converter.

AC voltage controllers: Single phase AC voltage controller with R & RL load.

Inverters – Single phase half bridge and full bridge inverter, Three Phase inverters-PWM Techniques.

DC choppers – Step up chopper –step down chopper - buck-boost & buck boost-switching regulators.

Electric Drives - Block diagram - concept of DC drive & AC drives.

v) (a) TEXT BOOKS

1) Ned Mohan, Tore M. Undeland, William P. Robbins, *Power Electronics: Converters, Applications, and Design*, Wiley India, 3rd Edition, 2018.
2) Dubey G K, *Fundamentals of Electrical Drives*, Narosa Publishing House, New Delhi, 2nd Edition, 2012.
3) Robert W. Erickson, Dragan Maksimovic, *Fundamentals of Power Electronics*, Springer, 3rd Edition, 2001.

(b) REFERENCES

1) Rashid M H, *Power Electronics – Circuits, Devices and Applications*, Prentice Hall of India, New Delhi, 4th edition, 2014.
2) Robert Bausiere, FrancisLabrique, GuySeguier, *Power Electronic Converters: DC-DC Conversion*, Springer, 2013.
3) P.S.Bimbhra, *Power Electronics*, Khanna Publishers, New Delhi, 6th edition, 2010.
4) Joseph Vithayathil, *Power Electronics*, Tata McGraw-Hill, New Delhi, 2010.
5) M.D.Singh and K.B.Khanchandani, *Power Electronics*, Tata McGraw Hills Publishing Company Limited, 2006.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Power Electronics**: Scope and applications-power electronics vs signal electronics. **Structure and principle of operation of power devices**- Power Diode, Power MOSFET & IGBT – Comparison-Basic principles of wideband gap devices-SiC, GaN **SCR-** Structure, Static characteristics & Switching (turn-on & turn-off) characteristics - di/dt& dv/dt protection – Turn-on methods of SCR - Two transistor analogy **Gate triggering circuits**- Requirements of isolation and synchronization in gate drive circuits, Opto and pulse transformer based isolation.	**11**
II	**Controlled Rectifiers (Single Phase)** – Half-wave controlled rectifier with R load– Fully controlled and half controlled bridge rectifier with R, RL and RLE loads (continuous & discontinuous conduction) – Output voltage equation- related simple problems **Controlled Rectifiers (3-Phase)** - 3-phase half-wave controlled rectifier with R load – Fully controlled & half-controlled bridge converter with RLE load (continuous conduction, ripple free) – Output voltage equation-Waveforms for various triggering angles -related simple problems (detailed mathematical analysis not required)	**12**
III	**AC voltage controllers (ACVC)** – 1-phase full-wave ACVC with R, & RL loads – Waveforms – RMS output voltage, Input power factor with R load **Inverters** – Voltage Source Inverters– 1-phase half-bridge & full bridge inverter with R and RL loads – THD in output voltage – 3-phase bridge inverter with R load – 120° and 180° conduction modes– Current Source Inverters **Voltage control in 1-phase inverters** – Pulse width modulation – Single pulse width, Multiple pulse width and Sine-triangle PWM– Modulation Index - Frequency modulation ratio.	**12**
IV	**DC-DC converters** – Step down and Step up choppers – Single-quadrant, Two-quadrant and Four quadrant chopper – Pulse width modulation & current limit control in dc-dc converters. **Switching regulators** – Buck, Boost & Buck-boost –Operation with continuous conduction mode – Waveforms – Design of Power circuits (switch selection, filter inductance and capacitance) -related simple problems	**12**

V	**Electric Drive**: Introduction to electric drives – Block diagram – advantages of electric drives- types of load – classification of load torque **DC Drives**: Single phase semi converter and single phase fully controlled converter drives. Dual Converters for Speed control of DC motor-1-phase and 3-phase configurations; Simultaneous and Non-simultaneous operation. Chopper controlled DC drives- Single quadrant chopper drives- Regenerative braking control **AC Drives**: Three phase induction motor speed control. Stator voltage control – stator frequency control - Stator voltage and frequency control (v/f)	**13**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U30E	INTERNET OF THINGS	PCC	3	1	0	4	2022

i) PRE-REQUISITE: EL2U30B-Microprocessors and Embedded Systems.

ii) COURSE OVERVIEW: The goal of this course is to introduce students to the different architectures used for connected smart devices. This course will enable students to program embedded devices used in different levels of IoT application. It also aims to expose students to design and develop Internet of Things based solution.

iii) COURSE OUTCOMES

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

CO 1	Explain the role of computer networks in IoT.	Understand
CO 2	Classify the different communication standards for IoT applications.	Understand
CO 3	Explain the functionalities and applications of various sensors and transmit the data to cloud-based platforms.	Understand
CO 4	Develop programs for IoT devices using micro-python language.	Apply
CO 5	Develop an IoT based solution for real time applications.	Apply

iv) SYLLABUS

Physical Design of IoT, Logical design of IoT, Design Challenges.

Internet Protocols and standards, IP addressing, Physical layer components, Sizing of networks.

IoT and M2M Communications, Big Data Analytics.Sensor technologies for IoT, data acquisition using embedded devices, data logging to cloud services-protocols and programming.Embedded devices for IoT: Sensor interfacing and data acquisition using target boards like Raspberry Pi 4B, ARM EMBED, ESP32, Arduino boards.IoT Applications.

v) (a) TEXT BOOKS

1) Simone Cirani, Internet of things: Architecture, protocols and standards, Wiley, 2019.
2) Charles Bell, MicroPython for the Internet of Things: A Beginner's Guide to programming with Python on Microcontrollers, Apress, 2017.
3) B.K Thripathy, J Anuradha, Internet of things (IoT) - technologies, applications, challenges and solutions, CRC press, 2018.
4) Raj Kamal, Internet of Things: Architecture and Design Principles, McGraw Hill (India) Private Limited, 2017.
5) Peter Waher, Mastering Internet of Things: Design and create your own IoT applications using Raspberry Pi 3, 1st Edition, Packt Publishing, 2018.

(b) REFERENCES

1) Qusay F. Hassan, Internet of Things A to Z: Technologies and applications, IEEE press, 2018
2) Gary Smart, Practical Python Programming for IoT: Build advanced IoT projects using Raspberry Pi MQTT, RESTful APIs, Web Sockets, and Python 3, Packt Publishing Ltd, 2020
3) Gaston C. Hillar, MQTT Essentials - A Lightweight IoT Protocol, Packt Publishing Ltd, 2017.
4) Alasdair Gilchrist, Industry 4.0 The Industrial Internet of Things, Apress, 2016.
5) David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, First Edition, Cis CO Press, 2017.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction**: Definition and Characteristics of IoT, Physical Design of IoT: Things in IoT, IoT Protocols, Logical Design of IoT: IoT Functional Blocks, IoT Communication Models, IoT Communication APIs, IoT Enabling Technologies. Design challenges – power consumption and security issues. **Computer networks**: Internet-protocols and standards-OSI model- TCP/IP protocol suite. IP addressing – IPv4 and IPv6, Physical layer components- Switch, Router, Access point, station, Server, Client, Port, Gateway. Sizing of network- LAN, MAN, WAN.	**12**
II	**IoT and M2M Communications:** Introduction, M2M, M2M applications, Differences between M2M and IoT, M2M standards- Bluetooth-LE, Zigbee, NFC, Wifi and LoRaWAN. Data logging and cloud services- CoAP, MQTT and JSON. Big data analytics (concepts only).	**12**
III	**Sensor technologies for IoT-** Wireless sensor network. Voltage, Current, Speed, Temperature and humidity sensors and data acquisition using embedded devices- block diagram. Data logging to cloud services- protocols and programming.	**10**
IV	**Embedded devices for IoT.** Introduction to Python programming and embedded programming using micropython. Sensor interfacing and data acquisition using target boards like Raspberry Pi 4B, ARM EMBED, ESP32, Arduino boards. Programming examples for data logging to the cloud using micropython. (Assignments on hardware implementation using these or similar boards may be given.)	**14**
V	**IoT applications:** Energy management and smart grid applications. IoT based home automation, Smart metering for electricity consumers. IoT based weather stations, Agriculture- smart farming, Automobile IoT- Electric vehicles-platform and software, Industrial IoT.	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U30F	COMPUTER COMMUNICATION AND NETWORK SECURITY	PCC	3	1	0	4	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW: This course provides a comprehensive understanding of computer networks, protocols, security principles, and practices, enabling them to design, manage, and secure robust network systems and effectively address contemporary network challenges.

iii) COURSE OUTCOMES

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

CO 1	Explain computer networks and the Internet, encompassing concepts from network architecture and protocols to application layer principles.	Understand
CO 2	Apply knowledge of transport layer services, multiplexing, demultiplexing, and congestion control principles to analyze UDP and TCP protocols.	Apply
CO 3	Apply error detection and correction techniques, understand multiple access protocols, and analyze link layer protocols in LAN environments, including DHCP and data center networking.	Apply
CO 4	Apply principles of cryptography and cryptanalysis to analyze substitution techniques like Caesar Cipher, Monoalphabetic Cipher, etc., for network security.	Apply
CO 5	Apply knowledge of message integrity, digital signatures, end-point authentication, and various security protocols like SSL, IPsec, and VPNs to secure network communications, including wireless LANs.	Apply

iv) SYLLABUS

Computer Networks and the Internet, Application Layer, Electronic Mail in the Internet, DNS, Peer-Peer Distribution, Video Streaming and Content Distribution Network, Socket Programming. Transport Layer, Connectionless Transport: UDP, Connection – Oriented Transport: TCP, Principles of Congestion Control, TCP Congestion Control.

Network Layer, Routing Algorithms, OSPF, BGP, SDN Controller and SDN Network-control Applications, ICMP: The Internet Control Message Protocol, Network Management and SNMP. Link Layer and the LAN, Link Virtualization,

Introduction to Network Security: Cryptography, Cryptanalysis and Brute-Force Attack.

Substitution Techniques, Message Integrity and Digital Signatures, End-Point Authentication, Securing E-Mail, IPsec and Virtual Private Networks (VPNs), AH and ESP Protocols, IKE, Securing Wireless LANs.

v) (a) TEXT BOOKS

1. William Stallings., Cryptography and Network Security: Principles and Practice, Pearson, 2017.
2. James Kurose., & Keith Ross., Computer Networking: A Top-Down Approach, 7th Edition, Pearson, 2017.

(b) Reference Books

1. Jie Wang., Zachary A. Kissel., Introduction To Network Security Theory And Practice, Wiley, 2017.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Computer Networks and the Internet, Network edge, Network Core, Delay, loss and throughput in packet switched networks, Protocol Layers and their service models, Networks under attack, History of Computer Networking and the Internet (Can be given as an Assignment) Application Layer: Principles of network application, Web and HTTP, Electronic Mail in the Internet, DNS, Peer-Peer Distribution, Video Streaming and Content Distribution Network, Socket Programming.	**13**
II	Transport Layer: Introduction to transport layer services, Multiplexing and Demultiplexing, Connectionless Transport: UDP, Principles of reliable Data Transfer, Connection – Oriented Transport: TCP, Principles of Congestion Control, TCP Congestion Control. Network Layer: Overview of network layer, Router basics, IPv4, IPv6, Generalized Forwarding and SDN. Routing Algorithms, Intra-AS Routing in the Internet: OSPF, Routing Among the ISPs: BGP, SDN Controller and SDN Network-control Applications, ICMP: The Internet Control Message Protocol, Network Management and SNMP.	**12**
III	Link Layer and the LAN: Error-Detection and Correction Techniques, Multiple Access Links and Protocols, Switched Local Area Networks, Link Virtualization: A Network as a Link Layer, Data Centre Networking, DHCP, UDP, IP, and Ethernet, Web Client-Server Interaction: TCP and HTTP.	**12**
IV	Introduction to Network Security: Network Security-Introduction, Principles of Cryptography, Cryptanalysis and Brute-Force Attack. Substitution Techniques: Caesar Cipher, Monoalphabetic Cipher, Playfair Cipher, Hill Cipher, Polyalphabetic Cipher, One-Time Pad.	**12**
V	Message Integrity and Digital Signatures, End-Point Authentication, Securing E-Mail, Securing TCP Connections: SSL, IPsec and Virtual Private Networks (VPNs), AH and ESP Protocols, IKE, Securing Wireless LANs.	**11**
	Total hours (Approx.)	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U30G	ALGORITHM ANALYSIS AND DESIGN	PCC	3	0	0	3	2022

i) PRE-REQUISITE: ES0U10E Programming in C, EL2U20B Data Structures

ii) COURSE OVERVIEW:

The course is designed to acquaint students with computer algorithm design and analysis. These concepts form the foundational framework of computer science and are essential for the effective work of any programmer. The primary objective of this course is to furnish students with a strong foundation in designing and analysing key algorithmic classes. By the course's conclusion, students will be proficient in creating their own variations of algorithms for specific computational tasks and will be capable of evaluating and contrasting their efficiency and performance.

iii) COURSE OUTCOMES

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

CO 1	Develop time and space complexities in asymptotic notations for any given algorithm	Apply
CO 2	Construct recurrence equations and solve it using Iteration, Recurrence Tree, Substitution and Master's Method to compute time complexity of algorithms.	Apply
CO 3	Illustrate Graph traversal algorithms and advanced Data structures like AVL trees and Disjoint set operations.	Understand
CO 4	Demonstrate Divide-and-conquer, Greedy Strategy, Dynamic programming, Branch-and Bound and Backtracking algorithm design techniques	Understand
CO 5	Identify a problem as computationally tractable or intractable, and discuss strategies to address intractability	Apply
CO 6	Identify the suitable design strategy to solve a given problem.	Apply

iv) SYLLABUS

Introduction to Algorithm Analysis, Time and Space Complexity, Analysis of Recursive Algorithms, Advanced Data Structures and Graph Algorithms, Self-Balancing Tree - AVL Trees, DFS and BFS traversals, Topological Sorting, Divide & Conquer and Greedy Strategy, Dynamic Programming, Back Tracking and Branch & Bound, Control Abstraction, Branch and Bound Algorithm for Travelling Salesman Problem, Introduction to Complexity Theory, Tractable and Intractable Problems, Complexity Classes, Approximation algorithms

v) (a) TEXT BOOKS

1) T.H.Cormen, C.E.Leiserson, R.L.Rivest, C. Stein, Introduction to Algorithms, 2nd Edition, Prentice-Hall India (2001)
2) Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, "Fundamentals of Computer Algorithms", 2nd Edition, Orient Longman Universities Press (2008)
3) Sara Baase and Allen Van Gelder —Computer Algorithms, Introduction to Design and Analysis, 3rd Edition, Pearson Education (2009)

(b) REFERENCES

1) Jon Kleinberg, Eva Tardos, "Algorithm Design", First Edition, Pearson (2005)

2) Robert Sedgewick, Kevin Wayne, "Algorithms",4th Edition Pearson (2011)
3) GIlles Brassard, Paul Brately, "Fundamentals of Algorithmics", Pearson (1996)
4) Steven S. Skiena, "The Algorithm Design Manual", 2nd Edition, Springer (2008)

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Algorithm Analysis- Characteristics of Algorithms, Criteria for Analysing Algorithms, Time and Space Complexity - Best, Worst and Average Case Complexities, Asymptotic Notations - Big-Oh (O), Big- Omega (Ω), Big-Theta (Θ), Little-oh (o) and Little- Omega (ω) and their properties. Classifying functions by their asymptotic growth rate, Time and Space Complexity Calculation of simple algorithms. Analysis of Recursive Algorithms: Recurrence Equations, Solving Recurrence Equations – Iteration Method, Recursion Tree Method, Substitution method and Master's Theorem (Proof not required).	**9**
II	Self-balancing Tree - AVL Trees (Insertion and deletion operations with all rotations in detail, algorithms not expected); Disjoint Sets- Disjoint set operations, Union and find algorithms. DFS and BFS traversals - Analysis, Strongly Connected Components of a Directed graph, Topological Sorting.	**10**
III	Control Abstraction of Divide and Conquer- 2-way Merge sort, Strassen's Algorithm for Matrix Multiplication-Analysis. The Control Abstraction of Greedy Strategy- Fractional Knapsack Problem, Minimum Cost Spanning Tree Computation- Kruskal's Algorithms - Analysis, Single Source Shortest Path Algorithm - Dijkstra's Algorithm-Analysis.	**8**
IV	The Control Abstraction- The Optimality Principle- Matrix Chain Multiplication-Analysis, All Pairs Shortest Path Algorithm - Floyd-Warshall Algorithm-Analysis. The Control Abstraction of Back Tracking – The N Queen's Problem. Branch and Bound Algorithm for Travelling Salesman Problem.	**9**
V	Tractable and Intractable Problems, Complexity Classes – P, NP, NP- Hard and NP-Complete Classes- NP Completeness proof of Clique Problem and Vertex Cover Problem- Approximation algorithms- Bin Packing, Graph Coloring. Randomized Algorithms (Definitions of Monte Carlo and Las Vegas algorithms), Randomized version of Quick Sort algorithm with analysis.	**9**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U32A	ADVANCED MICROCONTROLLERS	PEC	3	0	0	3	2022

i) PRE-REQUISITE: EL2U20D Computer Organization and Architecture, EL2U30B Microprocessors and Embedded Systems

ii) COURSE OVERVIEW: This course is designed to provide students with the knowledge they need to work with Advanced Microcontrollers. The course emphasizes hardware and software equally so students can design new, state-of-the-art microcontroller systems.

iii) COURSE OUTCOMES

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

CO 1	Apply the knowledge of Embedded C and Assembly Programming to program dsPIC30F microcontroller	Apply
CO 2	Explain the architecture and various peripherals of dsPIC30F	Understand
CO 3	Infer the ARM processor architecture and its assembly language programming	Understand
CO 4	Interpret the ARM processor organization and the Thumb Instruction set	Understand
CO 5	Explain the Architectural support for high level languages and system development of an ARM processor	Understand

iv) SYLLABUS

16 bit microcontrollers - dsPIC30F CPU, Peripherals of dsPIC30F,ARM processor architecture, ARM programming, ARM organization and implementation, Architectural support for high level languages, Thumb instruction set, architectural support for system development.

v) (a) TEXT BOOKS

1) Steve Furber, ARM system-on-chip architecture, Addison Wesley, Second Edition, 2000
2) dsPIC 30F Programmer's Reference Manual, Microchip

(b) REFERENCES

1) Andrew N. Sloss, Dominic Symes, Chris Wright, *ARM System Developer's Guide Designing and Optimizing System Software*, Morgan Kaufmann Publishers 2004
2) Tammy Noergaard, Embedded Systems Architecture*, A Comprehensive Guide for Engineers and Programmers*, Newnes – Elsevier 2nd edition, 2012
3) Lusio Di Jasio, *Programming 16-bit PIC microcontrollers in C*, Newnes – Elsevier 2nd edition, 2012
4) Tim Wilshurst,*Designing Embedded Systems with PIC Microcontrollers*, Newnes – Elsevier 2nd edition, 2010
5) www.microchip.com/dsPIC30F

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to 16-bit microcontrollers** – dsPIC30F CPU, Data memory, Program Memory.Instruction set – Programming in Assembly and C, Interrupt Structure.	**9**
II	**Peripherals of dsPIC 30F:** I/O Ports, Timers, Input Capture, Output Compare, Motor Control PWM, 10 bit A/D Converter, UART, CAN Unit, Application Development.	**9**
III	**ARM Processor Architecture**: The Acorn RISC Machine, Architectural inheritance, The ARM programmer's model, ARM development tools. **ARM Assembly Language Programming**: Data processing instructions, Data transfer instructions, Control flow instructions.	**10**
IV	**ARM Organization and Implementation:** Three stage pipeline ARM organization, five stage pipeline ARM organization, ARM instruction execution, ARM implementation, The ARM coprocessor interface. **Architectural Support for High-Level Languages**: Abstraction in software design, Data types, Floating-point data types, The ARM floating-point architecture, Expressions, Conditional statements, Loops, Functions and procedures, Use of memory, Run-time environment.	**9**
V	**The Thumb Instruction Set:** The Thumb bit in the CPSR, The Thumb programmer's model, Thumb implementation, Thumb applications. **Architectural Support for System Development**: The ARM memory interface.	**8**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U32B	ELECTROMAGNETIC THEORY AND COMPATIBILITY	PEC	3	0	0	3	2022

i) PRE-REQUISITE: ES0U10D Basics of Electrical Engineering, PH0U10A Engineering Physics, MA0U20A Partial Differential Equations and Complex Analysis.

ii) COURSE OVERVIEW:

The purpose of the course is to familiarize the students with the fundamental concepts of electrostatics, magnetostatics and electromagnetic fields. It enables the students to apply this knowledge in the determination of electric and magnetic fields and to summarize Maxwell's equations for different applications. It also introduces students to the concepts of electromagnetic wave propagation, transmission lines and electromagnetic interference and compatibility.

iii) COURSE OUTCOMES

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

CO 1	Apply vector analysis and co-ordinate systems to solve static electric and magnetic field problems.	Apply
CO 2	Apply Gauss's Law, Coulomb's law to evaluate electric fields and potentials for different charge distributions and capacitors.	Apply
CO 3	Solve magnetic fields due to various current distributions by applying Biot-Savart's law and Ampere's Circuital law.	Apply
CO 4	Interpret wave equations from Maxwell Equations for time varying fields and explain wave propagation through different media.	Understand
CO 5	Summarize the transmission line equations and parameters and to explain the sources of electromagnetic interference and the different EMI control techniques.	Understand

iv) SYLLABUS

Introduction to Co-ordinate Systems; Del operations; Divergence Theorem; Stokes' Theorem.

Coulomb's Law; Electric field intensity; Flux Density; Gauss's law; Potential-Potential Gradient; Poisson's and Laplace's equations; Capacitance and Inductance.

Biot-Savart's Law; Magnetic Field intensity; Magnetic Flux Density; Ampere's circuital law; Force between current carrying conductors; Magnetic potential.

Conductors and dielectrics; Continuity equation; Boundary conditions; Maxwell's Equations; Polarization.

Electromagnetic Wave Equations; Uniform Plane Waves; Poynting Theorem; Transmission Lines, Electromagnetic Interference.

v) (a) TEXT BOOKS

1) Matthew N.O. Sadiku, *Principles of Electromagnetics*, Oxford university Press, 2015.
2) Bakshi A.V. and Bakshi U.A., *Electromagnetic Theory*, Technical Publications, 2017.
3) John Kraus and Daniel Fleisch, *Electromagnetics with Applications*, McGraw-Hill Education, 2017.

(b) REFERENCES

1) William, H. Hayt. and John A. Buck, *Engineering Electromagnetics*, McGraw-Hill Education, 2017.
2) William, H. Hayt and John A. Buck, *Problems and Solutions in Electromagnetics,* McGraw- Hill Education, 2017.
3) Joseph A. Edminister, *Electromagnetics, Schaum's Outline Series*, McGraw-Hill Education, 2013.

vi) COURSE PLAN

Module	Contents	No. of hrs
I	**Introduction to Co-ordinate Systems:** Introduction to vector calculus and different co-ordinate systems- Rectangular, Cylindrical and Spherical Co- ordinate Systems; Co-ordinate transformation. Gradient of a Scalar field, Divergence of a Vector field and Curl of a Vector field- their physical interpretation, Laplacian of a scalar; Divergence Theorem, Stokes' Theorem.	**10**
II	**Electrostatics:** Coulomb's Law, Electric field intensity; Electric Flux and Flux Density; Gauss's law and its application to determine the field due to an infinite sheet charge. Electric Potential-Potential Gradient, Conservative property of electric field, Equipotential surfaces; concept of Electric Dipole; Capacitance of a co-axial cable and two-wire transmission line; Poisson's and Laplace's equations.	**9**
III	**Magnetostatics:** Biot-Savart's Law, Magnetic Field intensity due to finite and infinite current carrying wires; Magnetic field intensity on the axis of a circular and rectangular current carrying loop; Magnetic flux Density. Ampere's circuital Law and its application to find the magnetic field due to an infinite current carrying conductor; simple numerical problems on magnetostatics. Scalar and Vector magnetic potential.	**8**
IV	**Electric and magnetic fields in materials:** Boundary conditions for electric fields and magnetic fields. Conduction current and displacement current; Equation of continuity; Dielectric polarization; Expressions for electrostatic energy and energy density. Maxwell's Equations in Differential and Integral form for time-varying fields. **Electromagnetic Waves:** Wave Equations from Maxwell's Equations in point form; Wave equations in Phasor form.	**8**
V	**Uniform Plane Waves** -Propagation of Uniform Plane waves in free space, loss-less and lossy dielectric medium, good conductors; properties in different medium-attenuation constant, phase constant, propagation constant, intrinsic impedance; Skin effect and skin depth; simple numerical problems; Poynting Theorem. **Transmission lines**- Uniform lossless transmission lines - Transmission line equations, line parameters, Standing waves, Reflection coefficient and VSWR, Impedance matching. Electromagnetic compatibility, electromagnetic interference-types, sources, effects, and control techniques.	**10**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U32C	ENERGY STORAGE SYSTEMS	PEC	3	0	0	3	2022

i) PRE-REQUISITE: Nil.

ii) COURSE OVERVIEW: This course is to expose the students to the fundamental concepts of energy storage systems used in different applications.

iii) COURSE OUTCOMES

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

CO1	Interpret the role of energy storage in power systems.	Understand
CO2	Classify thermal, kinetic and potential storage technologies and their applications.	Understand
CO3	Compare Electrochemical, Electrostatic and Electromagnetic storage technologies.	Understand
CO4	Apply energy storage technology in renewable energy integration.	Apply
CO5	Enumerate energy storage technology applications for smart grids.	Understand

iv)SYLLABUS

Introduction to energy storage in power systems- General considerations

Overview on Energy storage technologies - Thermal energy, Potential energy: Pumped hydro-Compressed Air, Kinetic energy: Mechanical- Flywheel, Power to Gas

Overview on Energy storage technologies- Batteries- Parameters, Fuel cells, Electrostatic energy Electromagnetic energy, Comparative analysis, Environmental impacts.

Energy storage and renewable power sources- Wave - Wind – Tidal – Hydroelectric - Solar thermal technologies and Photovoltaics, Storage role in isolated and integrated power systems with renewable power sources.

Energy storage Applications - Smart grid, Smart house, Mobile storage system- Electric vehicles – Grid to Vehicle (G2V)-Vehicle to Grid (V2G), Battery SCADA, Hybrid energy storage systems.

v) (a) TEXT BOOKS

1) Osaka T., Datta M., “Energy Storage Systems in Electronics-New Trends in Electrochemical Technology”, CRC Press 2000.
2) Rand D.A.J., Moseley P.T., Garche J. and Parker C.D., “Valve regulated Lead–Acid Batteries”, Elsevier 2004.

(b) REFERENCES

1) Broussely M. and Pistoia G., “Industrial Applications of Batteries from Cars to Aerospace and Energy Storage”, Elsevier, 2007
2) Nazri G. A. and Pistoia G., “Lithium Batteries – Science and Technology”, Kluwer Academic Publishers, 2004

3) Larminie J., Dicks A. and Wiley-Blackwell, "Fuel Cell Systems Explained", 2nd Edition, Wiley Publications, 2013.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to energy storage in power systems:** Energy storage systems overview - Scope of energy storage, needs and opportunities in energy storage, comparison of storages and applications, Energy storage in the power and transportation sectors. Importance of energy storage systems in electric vehicles, Current electric vehicle market. Need and role of energy storage systems in power systems, General considerations, Energy and power balance in a storage unit.	9
II	**Overview on Energy storage technologies:** Thermal energy: General considerations - Storage media- Containment - Thermal energy storage in a power plant, Potential energy: Pumped Hydro-Compressed Air, Kinetic energy: Mechanical - Flywheel, Power to Gas - Hydrogen - Synthetic methane.	9
III	**Overview on Energy storage technologies:** Electrochemical energy - Batteries- Battery parameters: C-rating -SoC- DoD- Specific Energy- Specific power (numerical examples), Fuel cells, Electrostatic energy (Super Capacitors), Electromagnetic energy (Super conducting Magnetic Energy Storage), Comparative analysis, Environmental impacts of different technologies.	9
IV	**Energy storage and renewable power sources:** Types of renewable energy sources: Wind and Photovoltaics, Storage role in isolated power systems with renewable power sources, Storage role in an integrated power system with grid-connected renewable power sources.	8
V	**Energy storage Applications:** Smart grid, Smart microgrid, 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.	10
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U32D	DIGITAL IMAGE PROCESSING	PEC	3	0	0	3	2022

i) PRE-REQUISITE: EL2U31A Signals and Systems, Basics of Matrix Transformation

ii) COURSE OVERVIEW: This course aims to impart the knowledge of image fundamentals and mathematical transforms necessary for image transformations. The course familiarizes the students with image processing techniques like image segmentation, image enhancement and image compression.

iii) COURSE OUTCOMES

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

CO1	Explain the various aspects of digital image representation.	Understand
CO2	Apply matrix theory and mathematical transforms for image processing.	Apply
CO3	Apply the image enhancement techniques in spatial and frequency domain.	Apply
CO4	Interpret various image segmentation techniques.	Understand
CO5	Explain the techniques for compression and restoration of images.	Understand

iv) SYLLABUS

Digital Image Fundamentals: Image Representation- simple image formation model. Color image fundamentals- 2D sampling, quantization. Review of matrix theory - Toelpitz, Circulant and Block matrix. Review of Fourier transform and DFT – FFT. Image Enhancement in Spatial domain: Basic Gret level transforms, Histogram, Histogram processing: Smoothening and sharpening filters, Laplacian Filters. Image Enhancement in Frequency domain. Image segmentation: Segmentation and threshold function, Matching, Colour segmentation. Image compression: Need for image compression, Basics of image compression standards- JPEG, MPEG. Image restoration- Blind image Restoration. MATLAB implementation

v) (a) TEXT BOOKS

1) Rafael C. Gonzales, Richard E. Woods, “Digital Image Processing”, 3rd edition, Pearson Education India, 2013.
2) S Jayaraman, S Esakkirajan, T Veerakumar, “Digital image processing” ,5th edition, Tata Mc Graw Hill, 2015.
3) Malay K. Pakhira, “Digital Image Processing and Pattern Recognition”, 1st edition, PHI Learning Pvt. Ltd., 2011.

(b) REFERENCES

1) Anil Jain K, “Fundamentals of Digital Image Processing”, 3rd edition, PHI Learning Pvt. Ltd., 2011.
2) Kenneth R Castleman, “Digital Image Processing”, 2nd edition, Pearson Education, 2003.
3) Pratt William K, “Digital Image Processing”, 4th edition, John Wiley Publications, 2007.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Digital Image Fundamentals:** Image Representation, basic relationship between pixels, elements of DIP system, elements of visual perception-simple image formation model.Brightness, contrast, hue, saturation, Mach band effect Color image fundamentals- RGB, CMY, HIS model. 2D sampling, quantization, Grayscale resolution.	9
II	**Review of matrix theory:** row and column ordering- Toelpitz, Circulant and Block matrix. **Review of Fourier transform and DFT**- properties of 2D Fourier Transform- FFT- Separable image transforms- Walsh, Hadamard- Discrete Cosine Transform, Haar Transform.	9
III	**Image Enhancement in Spatial domain:** Basic Gret level transforms, Histogram, Histogram processing: equalization, Image subtraction, Image averaging. Smoothening and sharpening filters, Laplacian Filters. **Image Enhancement in Frequency domain:** Smoothing frequency domain filtering, Sharpening frequency domain filtering, Homomorphic filtering.	9
IV	**Image segmentation:** Segmentation and threshold function, Algorithms in thresholding, line detection, edge detection, edge linking by Graph Search Method, Hough Transform, Region based segmentation, Matching, Colour segmentation.	8
V	**Image compression:** Need for image compression, Huffman, Run length Encoding, Shift codes, vector quantization, transform coding. Basics of image compression standards- JPEG, MPEG. **Image restoration:** Inverse filtering, Least Mean Square filtering, Weiner filtering, Blind image Restoration. MATLAB implementation of Image Processing.	9
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U32E	MODERN ILLUMINATION CONTROL	PEC	3	0	0	3	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

Goal of this course is to provide an in-depth exploration of modern lighting techniques, technologies, and control systems used in architectural, commercial, and residential settings. Students will learn principles of lighting design, energy-efficient lighting solutions, and advanced control methodologies to create dynamic and sustainable illuminated environments.

iii) COURSE OUTCOMES

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

CO1	Explain the types, components and working of artificial lighting system	Understand
CO2	Develop lighting schemes for indoor applications	Apply
CO3	Develop lighting schemes for outdoor applications	Apply
CO4	Explain the various control strategies and circuits for lighting applications.	Understand
CO5	Explain the various Energy-Efficient Lighting Sources	Understand

iv) SYLLABUS

Lamp materials - glass, filament, phosphor coating, ceramics, electrodes, gases, capping cement - Types of luminaire, Design consideration, Indian standard recommendation

Interior Lighting design: Average lumen method - Space to mounting height ratio- Design of lighting systems for a medium area seminar hall using LED luminaires Special features of entrance, staircase, Corridor lighting

Exterior lighting design- Point to point method – Design of Street Lighting/road lighting – Spacing to mounting height ratio. Selection of lamp and projector, recommended method for aiming of lamp

Illumination Control circuits: Purpose of lighting control - Lighting control by transformer and ballasts - Electromagnetic & Electronic ballast - Operation & comparison in light control. Ignitors and starters

Energy-Efficient Lighting Sources - Daylight harvesting techniques-– dimmers, motion and occupancy sensors, photo sensors and timers. Selection of Lighting Control systems - Types of control systems (analog, digital, networked)- Dimming techniques and protocols (e.g., DALI, DMX) DMX control.

v) (a) TEXT BOOKS

1) Robert Simpson, *Lighting Control: Technology and Applications*, Taylor and Francis, 2003
2) Craig DiLouie, *Advanced Lighting Controls: Energy Savings, Productivity, Technology and Applications*, CRC Press, 2005
3) M K Giridharan, *Electrical System Design*, I K International Publishing House Pvt. Ltd, 2015

(b) REFERENCES

1) D.C. Pritchard, *Lighting*, 6th edition, Routledge, 2014
2) Jack L. Lindsey, *Applied Illumination Engineering* The Fairmont Press Inc.
3) M.A. Cayless, *Lamps and Lighting* , Routledge, 1996.
4) J.B.Murdoch, *Illumination Engineering from Edison's lamp to the laser* Macmillan Publishing company
5) Mohamed Boubekri, *Daylighting, Architecture and Health: Building Design Strategies* Architectural Press, UK

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Fundamentals of Light and Lighting Systems** Basics of light – Luminous flux, Lumen, Luminous intensity, Types of lamps – Fluorescent, LED, High & Low-pressure sodium vapour, Mercury vapour, Metal halide, Comparative analysis of lamp technologies – Energy efficiency, lifespan, color rendering, Types of luminaires – Reflectors, refractors, mounting types, Fixture selection based on applications.	9
II	**Interior Lighting Design** Illumination calculations – Average lumen method, Space to mounting height ratio, Interior lighting design – Seminar halls, offices, residential spaces, Factors affecting visual comfort, glare, and aesthetics, Lighting for staircases, corridors, and entrances, Human-centric lighting – Color temperature and circadian rhythms.	9
III	**Outdoor and Specialized Lighting** Road lighting design – Spacing to mounting height ratio, Requirements of good road lighting, Street lighting arrangements – Pole placements and fixture types, Flood lighting design – Selection of lamps and projectors, Facade lighting for buildings, Landscape and garden lighting, Sports lighting.	9
IV	**Smart and Automated Lighting Systems** Purpose of lighting control – Benefits of automation, Overview of dimmers, motion and occupancy sensors, photo sensors, and timers, Smart lighting for buildings and streets – Introduction to IoT-based lighting, Case studies on modern lighting automation in smart cities and smart homes.	9
V	**Sustainable and Energy-Efficient Lighting**	8

	Daylight factor – Daylight harvesting techniques, Benefits of daylighting, Overview of lighting control systems – Analog, digital, networked, Basics of dimming techniques – DALI, DMX for architectural lighting, Role of lighting in green buildings, Case studies on energy-efficient lighting in urban environments.	
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U32F	INTRODUCTION TO ARTIFICIAL INTELLIGENCE	PEC	3	0	0	3	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

The goal of this course is to introduce the basic principles, techniques, and applications of Artificial Intelligence. Emphasis will be placed on the teaching of these fundamentals.

iii) COURSE OUTCOMES

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

CO1	Demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations.	Understand
CO2	Apply basic principles of AI for formulation of solutions that require problem solving, knowledge representation, and learning.	Apply
CO3	Demonstrate awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, artificial neural networks and other machine learning models.	Understand
CO4	Familiarize AI techniques for text and speech processing	Understand

iv) SYLLABUS

Introduction, Characteristics of Intelligent Agents, Typical Intelligent Agents, Problem Solving Approach to Typical AI problems.

Problem solving Methods: Search Strategies, Local Search Algorithms and Optimization Problems - Searching with Partial Observations, Game Playing, Stochastic Games, Constraint Satisfaction Problems.

First Order Predicate Logic: Unification, Resolution, Knowledge Representation – Ontological Engineering, Categories and Objects, Events, Reasoning Systems for Categories, Reasoning with Default Information.

Learning: Forms of learning, Supervised learning, Regression and Classification with linear models, Artificial Neural Networks, Support Vector Machines.

AI Communication: Natural Language Processing, Information Retrieval, Information Extraction, Machine Translation, Speech Recognition.

v) (a) TEXT BOOKS

1) S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach, Prentice Hall, Third Edition, 2009.

(b) REFERENCES

1) M. Tim Jones, Artificial Intelligence: A Systems Approach (Computer Science), Jones and Bartlett Publishers, Inc.; First Edition, 2008.
2) Nils J. Nilsson, The Quest for Artificial Intelligence, Cambridge University Press, 2009.
3) Gerhard Weiss, Multi Agent Systems, Second Edition, MIT Press, 2013.
4) David L. Poole and Alan K. Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press, 2010.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction**: Definition – Future of Artificial Intelligence – Characteristics of Intelligent Agents – Typical Intelligent Agents – Problem Solving Agents.	**6**
II	**Problem solving Methods**: Search Strategies- Uninformed, Informed, Heuristics, Local Search Algorithms and Optimization Problems -Searching with Partial Observations. **Game Playing**: Optimal Decisions in Games, Alpha-Beta Pruning, Stochastic Games, Constraint Satisfaction Problems – Constraint Propagation, Backtracking Search.	**12**
III	**First Order Predicate Logic**: Propositional vs first-order inference, Unification, Forward Chaining, Backward Chaining, Resolution. **Knowledge Representation:** Ontological Engineering, Categories and Objects, Events, Mental Events and Mental Objects, Reasoning Systems for Categories, Reasoning with Default Information.	**12**
IV	**Learning**: Forms of learning, Supervised learning, Regression and Classification with linear models, Artificial Neural Networks, Support Vector Machines.	**8**
V	**AI Communication**: Natural Language Processing – Language Models, Information Retrieval, Information Extraction, Machine Translation, Speech Recognition.	**7**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U32G	SOFT COMPUTING TECHNIQUES	PEC	3	0	0	3	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

The goal of this course is to provide an exposure to the students on the fundamental concepts of different soft computing techniques namely, Artificial Neural Networks, Fuzzy logic and Genetic algorithms. It gives an insight into the different types of Artificial Neural Network architectures, the learning processes and algorithms, the properties and operations of fuzzy logic, the working of a fuzzy logic system, the operators of Genetic Algorithms and some hybrid systems.

iii) COURSE OUTCOMES

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

CO1	Describe the basics of Fuzzy Logic, Artificial Neural Networks and Genetic Algorithm.	Understand
CO2	Apply fuzzy logic techniques to control a system.	Apply
CO3	Distinguish the different Artificial Neural Network architectures and the different learning methods for training of ANNs.	Understand
CO4	Utilize genetic algorithm techniques to find the optimal solution of a given problem.	Understand

iv) SYLLABUS

Introduction, Fuzzy Sets, fuzzy membership functions, operations on fuzzy sets, properties of fuzzy sets, fuzzy relations, Fuzzy logic, fuzzy reasoning, Fuzzy Inference Systems.

Artificial Neural Networks: Biological foundations, ANN models, McCulloch-Pitts neuron model, Perceptron, Neural network architecture and learning, Activation functions, Learning process, Pattern classifiers, Pattern associators, Competitive Neural Networks, Back propagation network and its architecture, Radial basis function networks.

Elementary search techniques, Advanced search strategies, Hybrid Systems.

v) (a) TEXT BOOKS

1) Samir Roy, Udit Chakraborty, Introduction to Soft Computing Neuro-Fuzzy and Genetic Algorithms, Pearson Publications, 2013.
2) S. Rajasekharan, G. A. Vijayalakshmi Pai, Neural Network, Fuzzy Logic and Genetic Algorithms Synthesis and Applications, Prentice Hall India, 2003.
3) Simon Haykin, Neural Networks a Comprehensive foundation, Pearson Education, 1999.

(b) REFERENCES

1) S. N. Sivanandan, S. N. Deepa, Principles of Soft Computing, Wiley India, 2007.
2) J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro-Fuzzy and Soft Computing, Prentice Hall, 1997.
3) Timothy J. Ross, Fuzzy logic with Engineering Applications, Wiley Publications, 3rd edition, 2010.
4) Driankov D., Hellendoorn H., Reinfrank M, An Introduction to Fuzzy Control, Narosa Publications, 1993.
5) Bart Kosko, Neural Network and Fuzzy Systems, Prentice Hall of India, 2002.
6) Zurada J. M., Introduction to Artificial Neural Systems, Jaico Publishers, 2003.

7) Hassoun Mohammed H., Fundamentals of Artificial Neural Networks, Prentice Hall of India, 2002.
8) Suran Goonatilake & Sukhdev Khebbal (Eds.), Intelligent Hybrid Systems, John Wiley, 1995.
9) D. E. Goldberg, Genetic Algorithms in Search Optimisation and Machine Learning, Pearson Education, 1989.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction**: What is Soft Computing, Fuzzy Systems, Rough Sets, Artificial Neural Networks, Evolutionary Search Strategies. **Fuzzy Sets**: A review on crisp sets, fuzzy sets, fuzzy membership functions, operations on fuzzy sets, properties of fuzzy sets, fuzzy relations, fuzzy extension principle.	**6**
II	**Fuzzy logic**: Fuzzy logic basics, fuzzy truth in terms of fuzzy sets, fuzzy rules, fuzzy reasoning. **Fuzzy Inference Systems**: Fuzzification, application of fuzzy operators on the antecedent parts of the rules, evaluation of the fuzzy rules, aggregation of output fuzzy sets across the rules, defuzzification. Fuzzy logic controllers with examples.	**9**
III	**Artificial Neural Networks**: Biological foundations – ANN models - Characteristics of the brain, Computation in terms of patterns, McCulloch-Pitts neuron model, Perceptron. **Neural network architecture and learning**: Single layer feedforward ANNs, multilayer feedforward ANNs, competitive networks, recurrent networks. Activation functions, Learning process - Supervised and unsupervised learning.	**10**
IV	**Pattern classifiers**: Hebb nets, Perceptrons, ADALINE, MADALINE. **Pattern associators**: Hetero-associative nets, Hopfield networks. **Competitive Neural Networks**: Kohonen's Self-organizing Map (SOM), Adaptive Resonance Theory (ART). **Back propagation network** and its architecture, Derivation of the back-propagation algorithm. Radial basis function networks.	**10**
V	**Elementary search techniques**: State spaces, state space search, Heuristic search - Best-first Search, Generalized State Space Search, Hill Climbing, Constraint Satisfaction, Measures of Search. **Advanced search strategies**: Natural evolution, Genetic Algorithms, Multi-objective Genetic Algorithms, Simulated Annealing. **Hybrid Systems**: Adaptive Neuro-fuzzy Inference System (ANF1S), Genetic algorithm based back propagation networks, fuzzy genetic systems.	**10**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U32H	INTRODUCTION TO SIGNAL PROCESSING	PEC	3	0	0	3	2022

i) PRE-REQUISITE: EL2U31A Signals and Systems

ii) COURSE OVERVIEW:

This course introduces the discrete Fourier transform (DFT) and its computation using direct method and fast Fourier transform (FFT). Techniques for designing infinite impulse response (IIR) and finite impulse response (FIR) filters from given specifications are also introduced. Various structures for realization of IIR and FIR filters are discussed. Detailed analysis of finite word-length effects in fixed point DSP systems is included. Architecture of a digital signal processor is also discussed.

iii) COURSE OUTCOMES

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

CO1	Construct Discrete Fourier transform and Fast Fourier transform.	Apply
CO2	Explain the various structures for realization of IIR and FIR discrete-time systems.	Understand
CO3	Develop IIR (Butterworth and Chebyshev) digital filters using impulse invariant and bilinear transformation methods.	Apply
CO4	Develop FIR filters using frequency sampling method and window function method.	Apply
CO5	Compare fixed point and floating-point arithmetic used in digital signal processors and discuss the finite word length effects.	Apply
CO6	Explain the architecture of digital signal processors and the applications of DSP.	Understand

iv) SYLLABUS

Discrete Fourier transform (DFT) – inverse DFT (IDFT) - properties of DFT -Filtering of long data sequences - Fast Fourier transform (FFT).

Introduction to FIR and IIR systems - Realization of IIR systems - conversion of lattice to direct form and vice-versa - signal flow graphs and transposed structures - Realization of FIR systems.

Design of IIR filters - frequency transformation in analog domain - design of LP, HP, BP, BS IIR digital filters using impulse invariance and bilinear transformation.

Finite word length effects in digital Filters, Digital signal processor architecture based on Harvard architecture (block diagram) – pipelining, dedicated hardware multiplier/accumulator, special instructions dedicated to DSP, replication, on-chip memory cache, extended parallelism, comparison of fixed-point and floating-point processor – applications of DSP

v) (a) TEXT BOOKS

1) John G. Proakis & Dimitris G.Manolakis, “Digital Signal Processing Principles,Algorithms & Applications”, Pearson
2) Haykin S. & Veen B.V., “Signals & Systems”, John Wiley Publications, 2nd edition, 2007.
3) Oppenheim A.V, Willsky A.S. & Nawab S.H., “Signals and Systems”, Pearson Publications, 2nd edition, 2015.
4) I J Nagrarth, “Signals and Systems”, McGraw Hill Education, 2009.

(b) REFERENCES

1) Emmanuel Ifeachor & Barrie W Jervis, "Digital Signal Processing", Pearson, 13th edition, 2013.
2) P.Ramesh Babu, R. Anandanadarajan, "Signals and Systems", SCITECH Publications Pvt. Ltd, 2008.
3) Li Tan, "Digital Signal Processing, Fundamentals & Applications", Academic Press,Ist edition, 2008.
4) D. Ganesh Rao & Vineeta P Gejji, "Digital Signal Processing, A Simplified Approach", Sanguine Technical Publishers, 2nd edition, 2008.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Review of signals and systems - Frequency domain sampling - Discrete Fourier transform (DFT) – inverse DFT (IDFT) - properties of DFT – linearity, periodicity, symmetry, time reversal, circular time shift, circular frequency shift, circular convolution, complex conjugate property – Filtering of long data sequences – over-lap save method, over-lap add method –Fast Fourier transform (FFT) – advantages over direct computation of DFT - radix -2 decimation-in-time FFT (DITFFT) algorithm, Radix-2 decimation-in-frequency FFT (DIFFFT) algorithm.	9
II	Introduction to FIR and IIR systems - Realization of IIR systems – direct form 1, direct form 2, cascade form, parallel form, lattice structure for all-pole system, lattice-ladder structure – conversion of lattice to direct form and vice-versa - signal flow graphs and transposed structures – Realization of FIR systems – direct form, cascade form, lattice structure, linear phase realization.	9
III	Conversion of analog transfer function to digital transfer function – impulse invariant transformation and bilinear transformation – warping effect Design of IIR filters – low-pass, high-pass, band-pass, band-stop filters – Butterworth and Chebyshev filter – frequency transformation in analog domain - design of LP, HP, BP, BS IIR digital filters using impulse invariance and bilinear transformation.	9
IV	Impulse response of ideal low pass filter – linear phase FIR filter – frequency response of linear phase FIR filter – Design of FIR filter using window functions (LP, HP, BP, BS filters) – Rectangular, Bartlett, Hanning, Hamming and Blackmann only – FIR filter design based on frequency sampling approach (LP, HP, BP, BS filters) Representation of numbers – fixed point representation – sign-magnitude, one's complement, two's complement – floating point representation – IEEE 754 32-bit single precision floating point representation	9
V	Finite word length effects in digital Filters – input quantization – quantisation noise power –steady-state output noise power – coefficient	9

	quantisation – overflow – techniques to prevent overflow - product quantization error – rounding and truncation – round-off noise power – limit cycle oscillations – zero input limit cycle oscillations – overflow limit cycle oscillations – signal scaling. Digital signal processor architecture based on Harvard architecture (block diagram) – Harvard architecture, pipelining, dedicated hardware multiplier/accumulator, special instructions dedicated to DSP, replication, on-chip memory cache, extended parallelism	
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U30H	COMPREHENSIVE COURSE WORK	PCC	1	0	0	1	2022

i) COURSE OVERVIEW:

The goal of this course is to assess the comprehensive knowledge gained by a student in core courses relevant to the branch of study.

ii) COURSE OUTCOMES

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

CO 1	Discuss the fundamental aspects of any engineering problem or situation relevant to the branch of study.	Understand

iii) SYLLABUS

The comprehensive course work will be conducted covering the following core courses studied from third to fifth semester.

Sl. No.	Course Code	Course Name
1	EL2U20A	Circuits and Networks
2	EL2U20B	Data Structures
3	EL2U20C	Instrumentation Systems
4	EL2U20E	Object Oriented Programming Using JAVA
5	EL2U20F	Digital Electronics
6	EL2U20D	Computer Organization and Architecture
7	EL2U30A	Database Management Systems
8	EL2U30B	Microprocessors and Embedded Systems
9	EL2U30C	Electrical Machines

iv) MARK DISTRIBUTION

Total Marks	ESE	ESE Duration
50	50	1 hour

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U38C	EMBEDDED SYSTEMS AND IoT LAB	PCC	0	0	3	2	2022

i) PRE-REQUISITE: EL2U30B Microprocessors and Embedded Systems.

i) COURSE OVERVIEW:

The objective of this course is to develop logic and coding skills that have wide scope in automation and various fields of engineering. The course exposes students to the operation of typical microcontrollers (8051) trainer kit. The students will also learn to use simulation tools for developing an embedded system and to upload/retrieve information from cloud.

ii) COURSE OUTCOMES

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

CO 1	Develop and execute assembly language programs for solving arithmetic and logical problems using 8051 microcontrollers.	Apply
CO 2	Develop embedded C program using the instruction set of 8051 microcontrollers.	Apply
CO 3	Design a microcontroller-based system with the help of various interfacing devices.	Apply
CO 4	Develop an IoT based system.	Apply

iii) LIST OF EXPERIMENTS

- 8051 ALP for
  (a) Data transfer: Block data movement, exchanging data, sorting, finding largest element in an array.
  (b) Arithmetic operations: Addition, subtraction, multiplication and division, Computation of square and cube of 16-bit numbers.
- ALP programming for the implementation of counters: HEX up and down counters, BCD up/down counters
- ALP programming for implementing Boolean and logical instructions: bit manipulation.
- ALP for implementing conditional call and return instructions
- 8051 Embedded C Programs for stepper motor control and DC speed control
- C Programs for Alphanumerical LCD panel/ keyboard interface.
- C Programs for ADC and DAC interfacing.
- Programming Arduino
- Programming Raspberry Pi to retrieve/upload information to cloud

iv) REFERENCES

1) R Kenneth J. Ayala, The 8051 Microcontroller, Cengage learning, 3/e, November 2007.
2) R. Lyla B.Das, Microprocessors and Microcontrollers, Pearson Education, India, 2011.
3) R Muhammed Ali Mazidi, The 8051 Microcontroller and Embedded Systems, Pearson Education, 2nd edition, January 2007.
4) R I.Scott Mackenzie, Raphel C.-W Phan, The 8051 microcontroller, 4th edition, July 2006.
5) Derek Molloy, Exploring Raspberry Pi: Interfacing to the real world with Embedded Linux

v) COURSE PLAN

12 experiments mandatory

Expt. No.	List of exercises/experiments	No. of hours
I	8051 ALP for Data transfer: a) Block data movement b) exchanging data c) sorting d) finding largest element in an array.	**3**
II	8051 ALP for Arithmetic operations: a) Addition, subtraction, multiplication and division. b) Computation of square and cube of 16-bit numbers.	**3**
III	8051 ALP for the implementation of counters: a) HEX up and down counters b) BCD up/down counters.	**3**
IV	ALP for implementing Boolean and logical instructions, bit manipulation.	
V	a) 8051 ALP for implementing conditional call and return instructions: Toggle the bits of port 1 by sending the values 55H and AAH continuously b) 8051 ALP to find Factorial of a number.	**3**
VI	8051 Embedded C programs for code conversions	**3**
VII	8051 Embedded C programs for serial transmission	**3**
VIII	a) 8051 Embedded C Programs for stepper motor control. b) 8051 Embedded C Programs for DC motor direction and speed control using PWM.	
IX	8051 Embedded C Programs for Alphanumerical LCD panel/ keyboard interface.	**3**
X	8051 Embedded C programs for Interfacing ADC and DAC	**3**
XI	Familiarization of Arduino IDE. a) LED blinking with different ON/OFF delay timings b) with i) inbuilt LED ii) externally Interfaced LED.	**3**
XII	Arduino based voltage measurement of 12V solar PV module/ 12V battery and displaying the measured value using I2C LCD display/upload to cloud	**3**
XIII	Arduino based DC current measurement using Hall-effect current sensor displaying the value using I2C LCD module/ upload to cloud	**3**
XIV	Upload/retrieve temperature and humidity data to cloud.	**3**
XV	IoT based dc motor speed control using arduino	**3**
XVI	IoT based home automation using arduino	**3**
XVII	Demo Experiments using 8051/Cloud Platforms	**3**
	Total Hours	**45**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	: **15 marks**
Continuous Assessment	: **30 marks**
Internal Test	: **30 marks**
Total	: **75 marks**

vii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- **One test of 30 marks**
- Duration – **2½ hours**

viii) END SEMESTER EXAMINATION PATTERN

a) Preliminary work	:	15 marks
b) Implementing the work/Conducting the experiment	:	20 marks
c) Program with Output	:	15 marks
d) Viva voce	:	20 marks
e) Record	:	5 marks
Total	**:**	**75 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U38D	NETWORKING LAB	PCC	0	0	3	2	2022

i) PREREQUISITE: ES0U10E Programming in C, EL2U20B Data Structures

ii) COURSE OVERVIEW:

The course enables the learners to get hands-on experience in network programming using Linux System calls and network monitoring tools. It covers implementation of network protocols and algorithms, configuration of network services and familiarization of network simulators. This helps the learners to develop, implement protocols and evaluate its performance for real world networks.

iii) COURSE OUTCOMES

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

CO1	Make use of network related commands and configuration files in Linux Operating System.	Apply
CO2	Develop network application programs and protocols.	Apply
CO3	Make use of network monitoring tools to analyze network traffic.	Apply
CO4	Develop and set up a network and configure different network protocols.	Apply
CO5	Develop simulation of fundamental network concepts using a network simulator.	Apply

iv) SYLLABUS

- Getting started with the basics of network configuration files and networking commands in Linux.
- To familiarize and understand the use and functioning of system calls used for network programming in Linux.
- Implement client-server communication using socket programming and TCP as transport layer protocol.
- Implement client-server communication using socket programming and UDP as transport layer protocol.
- Simulate sliding window flow control protocols. (Stop and Wait, Go back N, Selective Repeat ARQ protocols)
- Implement and simulate algorithms for Distance Vector Routing protocol or Link State Routing protocol.
- Implement Simple Mail Transfer Protocol.
- Implement File Transfer Protocol.
- Implement congestion control using a leaky bucket algorithm.
- Understanding the Wireshark tool.
- Design and configure a network with multiple subnets with wired and wireless LANs using required network devices. Configure commonly used services in the network.
- Study of NS2 simulator.

v) REFERENCES

1) W. Richard Stevens, Bill Fenner, Andy Rudoff, UNIX Network Programming: Volume 1, The Sockets Networking API, 3rd Edition, Pearson, 2015.
2) Lisa Bock, Learn Wireshark: Confidently navigate the Wireshark interface and solve real-world networking problems, Packt Publishing, 2019.

3) Teerawat Issariyakul, Ekram Hossain, Introduction to Network Simulator NS2,2nd Edition, Springer, 2019.

vi) COURSE PLAN

Expt. No.	List of exercises/experiments	No. of hours
I	Getting started with the basics of network configuration files and networking commands in Linux.	**3**
II	To familiarize and understand the use and functioning of system calls used for network programming in Linux.	**3**
III	Implement client-server communication using socket programming and TCP as transport layer protocol.	**3**
IV	Implement client-server communication using socket programming and UDP as transport layer protocol.	**3**
V	Simulate sliding window flow control protocols. (Stop and Wait protocols)	**3**
VI	Simulate sliding window flow control protocols. (Go back N, Selective Repeat ARQ protocols)	**3**
VII	Implement and simulate algorithms for Distance Vector Routing protocol or Link State Routing protocol.	**3**
VIII	Implement Simple Mail Transfer Protocol.	**3**
IX	Implement File Transfer Protocol.	**3**
X	Implement congestion control using a leaky bucket algorithm.	**3**
XI	Understanding the Wireshark tool.	**4**
XII	Design and configure a network with multiple subnets with wired LANs using required network devices. Configure commonly used services in the network.	**4**
XIII	Design and configure a network with multiple subnets with wireless LANs using required network devices. Configure commonly used services in the network.	**4**
XIV	Study of NS2 simulator	**3**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	**15 marks**
Continuous Assessment	:	**30 marks**
Internal Test	:	**30 marks**
Total	:	**75 marks**

viii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- **One test of 30 marks**
- Duration – **2½ hours**

ix) END SEMESTER EXAMINATION PATTERN

a.	Preliminary work	:	2 marks
b.	Algorithm	:	8 marks
c.	Program with Output	:	40 marks
d.	Viva voce	:	20 marks
e.	Record	:	5 marks
	Total	**:**	**75 marks**

B.TECH MINORS

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL0M30M	HYBRID AND ELECTRIC VEHICLES	VAC	3	1	0	4	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW: The main goal of this course is to expose the students to the fundamental concepts and trends in electric, hybrid and autonomous vehicles and it also discusses how to choose proper energy storage devices for vehicle applications. It gives an insight into the electric machines used and its control for application of electric vehicles. It also intends to deliver various charging systems and various communication protocols.

iii) COURSE OUTCOMES

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

CO1	Explain the basic concepts of Conventional, Electric and Hybrid Electric Vehicles.	Understand
CO2	Compare various configurations of Electric and Hybrid Electric drive trains based on application	Understand
CO3	Explain the propulsion unit for Electric and Hybrid vehicles.	Understand
CO4	Choose various energy storage devices based on their performance requirements for EV application and explain EV charging systems.	Understand
CO5	Select drive systems and various communication protocols for Electric Vehicles.	Understand

iv) SYLLABUS

Conventional Vehicles, Basics of vehicle performance, Basic Architecture of hybrid traction, Power flow control.

Electric Propulsion unit, Configuration and control of DC motor drives, Induction Motor drives, PM and SRM motor drives.

Energy Storage Requirements in Hybrid and Electric Vehicles, Battery, fuel cell, flywheel and supercapacitor-based energy storage.

Design of electric and hybrid electric vehicle, sizing of components.

Communication Systems, Energy Management Strategies, EV charging technologies and policies.

v) (a) TEXT BOOKS

1) Iqbal Husain: Electric and Hybrid vehicles: Design Fundamentals, CRC press, 3rd Edition, 2003.
2) Ehsani M., Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2005.
3) Gianfran C O Pistoia, Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure and the Market, Elsevier,2010.
4) Chan C. C. and Chau K. T., Modern Electric Vehicle Technology, OXFORD University Press, 2001.

(b) REFERENCES

1) James Larminie, John Lowry, Electric Vehicle Technology Explained, 2nd Edition Wiley 2003.
2) Fuhs A. E., Hybrid Vehicles and the Future of Personal Transportation, CRC Press, 2009.
3) Chris Mi, Abul Masrur M., Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, 2nd Edition, John Wiley & Sons Ltd,2017.
4) Sheldon S. Williamson, Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer, 2013.

(c) ONLINE RESOURCES

1) NPTEL courses/Materials (IITG, IITM, IITD) – Electric and Hybrid vehicles
   https://nptel.ac.in/courses/108/103/108103009/ (IIT Guwahati)
   https://nptel.ac.in/courses/108/102/108102121/ (IIT Delhi)
   https://nptel.ac.in/courses/108/106/108106170/ (IIT Madras)
2) FOC Control - video lecture by Texas Instruments
   https://training.ti.com/kr/field-oriented-control-permanent-magnet-motors
3) Sensored and sensorless FOC control of PMSM motors – Application notes (TI, MATLAB)
   https://www.ti.com/lit/an/sprabz0/sprabz0.pdf?ts=1620018267996&ref_url=https%253A%252F%252Fwww.google.com%252F
   https://in.mathworks.com/help/physmod/sps/ref/pmsmfieldorientedcontrol.html
4) Electric Vehicle Conductive AC Charging System
   https://dhi.nic.in/writereaddata/UploadFile/REPORT%20OF%20COMMITTEE636469551875975520.pdf.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Hybrid Electric Vehicles**: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. **Conventional Vehicles**: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.	12
II	**Hybrid Electric Drive-trains**: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. **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.	12
III	**Electric Propulsion unit:** Introduction to electric components used in hybrid and electric vehicles **DC Drives**: Review of Separately excited DC Motor control – Speed and torque equations - Independent control of orthogonal flux and torque - Closed loop control of speed and torque (block diagram only) **PMSM Drives**: PMSM motor basics – Independent control of orthogonal flux and torque (concept only)- Field Oriented Control (FOC) – Sensored and sensorless control (block diagram only)	**12**
IV	**Energy Storage**: Introduction to energy storage requirements in Hybrid and Electric Vehicles- Battery based energy storage systems, Battery Management System, Types of battery- Fuel Cell based energy storage systems- Supercapacitors -Hybridization of different energy storage devices **Overview of Electric Vehicle Battery Chargers** - On-board chargers, Electric Vehicle Supply Equipment (EVSE) - Grid to EVSE to On-board chargers to battery pack power flow block schematic diagrams. **Types of charging stations** - AC Level 1 & 2, DC - Level 3 –V2G concept-Types of Connectors - CHAdeMO, CCS Type1 and 2, GB/T - PIN diagrams and differences	**12**
V	**Sizing the drive system:** Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics **Vehicle Communication protocols**: Need and requirements - Functions of Control Pilot (CP) and Proximity Pilot (PP) pins, Communication Protocols - CAN, LIN, FLEXRAY (Basics only)- Power line communication (PLC) in EV	**12**
	Total hours	60

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL0M30N	INSTRUMENTATION AND AUTOMATION OF POWER PLANTS	VAC	4	0	0	4	2022

i) PRE-REQUISITE: NIL

ii) COURSE OVERVIEW: This course introduces measurements and instruments used in power plants. Automation of power plants and Supervisory control and data acquisition are also discussed.

iii) COURSE OUTCOMES

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

CO 1	Analyze different instruments used for measuring parameters in a power plant.	Analyze
CO 2	Explain various control systems in power plants.	Analyze
CO 3	Outline different components of SCADA for applications in power plants.	Understand

iv) SYLLABUS

Measurements in power plants**:** - Electrical measurements, Non electrical parameters, Drum level measurement, Smoke density measurement. Monitoring **:-** Measurement in boiler and turbine: Introduction to turbine supervisory system, Installation of non-contracting transducers for speed measurement. Control systems :- Controls in boiler: Boiler drum level measurement methods, feed water control, soot blowing operation, steam temperature control. Selection between boiler and turbine following modes. Cooling system, Automatic turbine runs up systems. SCADA systems:- Introduction to SCADA systems, SCADA Architecture, SCADA System Components, Intelligent Electronic Devices (IED), Applications, Interfacing of PLC with SCADA. SCADA applications:- Applications, Energy management System (EMS), Generation operation and management, Hydrothermal coordination.

v) a) TEXT BOOKS

1) P. K. Nag,"Power Plant Engineering" 2nd Edition, Tata McGraw-Hill Education, 2002.
2) R.K.Jain, "Mechanical and Industrial Measurements", 10th Edition, Khanna Publishers,New Delhi, 1995.
3) Sam. G.Dukelow, "The Control of Boilers", 2nd Edition, ISA Press, New York, 1991.
4) Stuart A. Boyer, 'SCADA-Supervisory Control and Data Acquisition', Instrument Society of America Publications,USA,2004.

b) REFERENCE:

1) David Lindsley, "Boiler Control Systems", McGraw Hill, New York, 1991.
2) Jervis M.J, "Power Station Instrumentation", Butterworth Heinemann, Oxford, 1993.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Measurements in power plants:** Electrical measurements – current, voltage, power, frequency, power factor etc. – non electrical parameters – flow of feed water, fuel, air and steam with correction factor for temperature – steam pressure and steam temperature – drum level measurement – radiation detector – smoke density measurement – dust monitor.	**12**
II	**Measurement in boiler and turbine:** Metal temperature measurement in boilers, piping. System for pressure measuring devices - smoke and dust monitor - flame monitoring. Introduction to turbine supervising system - pedestal vibration - shaft vibration – eccentricity measurement. Installation of non-contracting transducers for speed measurement.	**12**
III	**Controls in boilers:** Boiler drum level measurement methods - feed water control – soot blowing operation - steam temperature control - Coordinated control - boiler following mode operation - turbine following mode operation - selection between boiler and turbine following modes. Distributed control system in power plants interlocks in boiler operation – Cooling system - Automatic turbine runs up systems.	**12**
IV	**Introduction to SCADA systems:** Elements of a SCADA system - benefits of SCADA system - SCADA Architecture: Various SCADA architectures, advantages and disadvantages of each system. SCADA System Components: - Remote Terminal Unit-(RTU), Intelligent Electronic Devices (IED) - PLC: Block diagram, Ladder diagram, Functional block diagram, Applications, Interfacing of PLC with SCADA.	**12**
V	**SCADA Applications:** Operating states of a power system - Energy management System (EMS) – EMS framework – Generation operation and management – Load forecasting – unit commitment – hydrothermal coordination – Real time economic dispatch and reserve monitoring – real time automatic generation control	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL0M30P	CLOUD SERVICES AND INTERNET OF THINGS	VAC	4	0	0	4	2022

i) PRE-REQUISITE: EL2U30B-Microprocessors and Embedded Systems.

ii) COURSE OVERVIEW: The goal of this course is to introduce students to the concepts of cloud computing, cloud services and IoT. This course will enable students to explore the various sensors and protocols relating to IoT and make use of the cloud services in various IoT applications.

iii) COURSE OUTCOMES

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

CO1	Explain the fundamental concepts of cloud computing	Understand
CO2	Describe the different cloud services and deployment models.	Understand
CO3	Explain the basic concepts of IoT	Understand
CO4	Classify the different sensor technologies and communication standards for IoT applications.	Understand
CO5	Make use of cloud-based development platforms for various applications	Apply

iv) SYLLABUS

Overview of cloud computing: Definition, characteristics, architecture and infrastructure. Cloud management.

Cloud service Models: SaaS, PaaS, IaaS, FaaS, XaaS, Cloud deployment models. Cloud service providers.

IoT: Definition, characteristics, physical design, protocols, logic design.

Sensor technologies for IoT, data acquisition using embedded devices, data logging to cloud services-protocols and programming.

Cloud based IoT application development: development platforms, building, designing and deploying IoT application.

v) (a) TEXT BOOKS

1) Simone Cirani, Internet of things: Architecture, protocols and standards, Wiley, 2019.
2) Charles Bell, MicroPython for the Internet of Things: A Beginner's Guide to programming with Python on Microcontrollers, Apress, 2017.
3) B.K Thripathy, J Anuradha, Internet of things (IoT) - technologies, applications, challenges and solutions, CRC press, 2018.
4) Marinescu, D. C., "Cloud computing: theory and practice.", Morgan Kaufmann, 2017.

5) Buyya, R., Broberg, J., & Goscinski, A. M., "Cloud computing: Principles and paradigms" John Wiley & Sons, 2011.

(b) REFERENCES

1) Thomas, E., Zaigham M., Ricardo P., Cloud Computing Concepts, Technology & Architecture, Prentice Hall, 2013.
2) Buyya, R., Vecchiola, C., & Selvi, S. T. Mastering cloud computing: foundations and applications programming, Morgan Kaufmann, 2017.
3) Alasdair Gilchrist, Industry 4.0 The Industrial Internet of Things, Apress, 2016.
4) David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, First Edition, Cis CO Press, 2017.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Overview of Cloud Computing**: Definition and characteristics of cloud computing, Cloud Computing architecture, Cloud computing infrastructure, Virtualization, and hypervisors, Data center and server architecture, Cloud management in cloud computing, storage systems in cloud, networking in the cloud.	**10**
II	**Cloud service models**: Software as a service (SaaS), Platform as a service (PaaS), Infrastructure as a service (IaaS), Anything/Everything as a service (XaaS), Function as a Service (FaaS): Advantages and Disadvantages. Deployment models: Public, Private, Hybrid, Community clouds. Cloud service providers: AWS, Microsoft Azure, Google Cloud.	**12**
III	**Introduction to IoT**: Definition and Characteristics of IoT, Physical Design of IoT: Things in IoT, IoT Protocols, Logical Design of IoT: IoT Functional Blocks, IoT Communication Models, IoT Communication APIs, IoT Enabling Technologies. Design challenges – power consumption and security issues.	**10**
IV	**Sensor technologies for IoT-** Wireless sensor network and its integration with the cloud. Voltage, Current, Speed, Temperature and humidity sensors and data acquisition using embedded devices- block diagram. Data logging to cloud services- protocols and programming. IoT Device and Sensor Connectivity, Communication protocols for IoT devices (e.g., MQTT, CoAP). Wireless technologies for IoT (e.g., Wi-Fi, Bluetooth, Zigbee).	**14**
V	**Cloud-based IoT Application Development** Cloud Application Development Platforms. Introduction to cloud-based development platforms (e.g., AWS IoT Core, Azure IoT Hub). Setting up an IoT application environment in the cloud.	**14**

	Building and Deploying IoT Applications. Designing IoT applications with cloud integration. Deploying and testing IoT applications in the cloud.	
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EE0M30Q	ELECTRICAL SYSTEM DESIGN AND BUILDING SERVICES	VAC	3	1	0	4	2020

i) PRE-REQUISITE: Illumination Engineering, Electric Power supply and Distribution Systems, Energy efficiency in Buildings

ii) COURSE OVERVIEW:

Goal of this course is to expose the students to the fundamental concepts of Electrical System Design for Buildings, the methodology of design, the Regulatory standards and essential building services. It introduces the students to the efficient use of Computer aided design with Ms Excel and use of software tools like AutoCAD for the preparation of Single Line Diagrams.

iii) COURSE OUTCOMES

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

CO 1	Explain the significance of Electricity Act 2003 and National Electric Code (NEC-2011) in the design of Electrical installations.	Understand
CO 2	Develop the basis of design (BOD) for the project as per the given floor layout.	Apply
CO 3	Design a simple electric installation for domestic building and select main distribution board, sub distribution board, MCB, ELCB, MCCB as per the design.	Create
CO 4	Summarize the various design requirements for electrical installations of high-rise buildings, substations and solar PV systems	Understand
CO 5	Describe the importance of Lightning protection in a building and explain its components.	Understand

iv) SYLLABUS

Electrical System Design in Building Construction - The Indian Electricity Act 2003, National Electric Code (NEC 2011), National Building Code (NBC 2016)- Classification of voltages.

Design phase for electrical systems and develop the basis of design (BOD) for the project as per the given floor layout. Space requirements for a proper electrical installation as per NEC.

Design of electrical installations for domestic buildings - selection of main distribution board, sub distribution board, MCB, ELCB, MCCB - Electrical system layout designing.

Design requirements for high rise apartments and substation - Metering Panels - Cabling - Auxiliary and Emergency Power Supply.

Lightning protection system for a building – components - Code of practice for the protection of buildings.

v) (a) TEXT BOOKS

1) Theodore R. Bosela, Electrical Systems Design, Prentice Hall; 1st edition, 2002.

2) Giridharan M. K., Electrical Systems Design, I K International Publishers, New Delhi, 2nd edition, 2016.

3) Aleksandar Mratinkovic & Co., Design of Electrical Services for Buildings, 3G E-Learning LLC, 2017.

(b) REFERENCES

1) Steven J. Marrano, 'Electrical System Design and Specification Handbook for Industrial Facilities', Fairmont Press, 1998

2) Jain V. K., Amitabh Bajaj, Design of Electrical Installations, Lakshmi Publications Pvt. Ltd.

3) Ruzhu Wang, Xiaoqiang Zhai, Handbook of Energy Systems in Green Buildings, Springer; 1st edition, 2018.

4) Solanki C. S., Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers, Prentice Hall India Learning Private Limited, 2013.

5) National Electric Code, Bureau of Indian Standards publications, 2011.

6) Relevant Indian Standard – Specifications (IS – 732, IS – 746, IS – 3043, IS – 900)

DATA BOOK (Approved for use in the examination):

1) Giridharan M. K., Electrical Systems Design Data Hand book, I K International Publishers, New Delhi, 2011.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Electrical System Design in Building Construction. Role of Statutes: The Indian Electricity Act 2003, National Electric Code (NEC 2011), National Building Code (NBC 2016), Classification of Building services – Major and Minor building services – Design aspects of building services, Classification of voltages, standards and specifications.	10
II	Design phase for electrical systems based on project size and develop the basis of design (BOD) for the project. Procedures of calculating and designing the electrical system based on Plot area, Floor Area Ratio (FAR), Load Power Density (LPD), Total Connected Load (TCL), Transformer and Generator Capacity. Need of MS Excel tool for efficient design methodology. Space requirements for electrical installation as per NEC, room spaces to house electrical equipment-need for cable duct and cable trays- structural reinforcement for heavy equipment, clearances around electrical equipment.	13
III	General aspects of the design of electrical installations for domestic dwellings as per NEC guidelines–connected load calculation, sub	13

	circuits, selection of main distribution board, sub distribution board, MCB, ELCB- selection of cables for sub circuit. Electrical drawings for the given project including floor plans and schematic diagrams. Practical Exercise – Design of electrical system of residential building using MS Excel	
IV	Design requirements for high rise apartments- commercial and residential buildings– Substations, Primary and Secondary protection, Earthing calculations - Metering Panels – Cabling – Auxiliary and Emergency Power Supply arrangements. Introduction to Solar PV installations and its statutory requirements.	**12**
V	Lightning protection system for a building and building services, Role of grounding in lightning protection systems, Main components of a lightning protection system, IS 2309 (2010): Code of practice for the protection of buildings and allied structures against lightning. NBC – IS / IEC 62305.	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	**10 marks**
CA Exams (2 numbers)	:	**25 marks**
Assignment/Project/Case study etc.	:	**15 marks**
Total	:	**50 marks**

viii)) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

B.Tech (HONOURS)

SEMESTER 5

Course Code	Course Name	L-T-P	Credit
EL2H30A	Process Automation	4-0-0	4
EL2H30B	Mathematics for Machine Learning	4-0-0	4
EL2H30C	Micro Grids	4-0-0	4
EL2H30D	Electric Vehicle Technology	4-0-0	4

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2H30A	PROCESS AUTOMATION	VAC	4	0	0	4	2022

PRE-REQUISITE: Maths – Ordinary Differential Equations and Laplace Transforms

i) **COURSE OVERVIEW**: The course aims to familiarize students with the concepts of process control. It presents basic control system concepts to enable students to model and analyze physical systems in the time domain. Students will be introduced to classical controllers and advanced control strategies used in process control. The different components like actuators, control valves, PLCs and industrial robots used for process automation will also be introduced.

ii) **COURSE OUTCOMES**

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

CO1	Explain the basic concepts of control systems	Understand
CO2	Apply time domain techniques for response analysis of physical systems	Apply
CO3	Explain the concepts of system stability, types of classical controllers and advanced control strategies in process control.	Understand
CO4	Illustrate the architecture of Industrial Automation Systems and its components	Understand
CO5	Build simple ladder programs for operation of PLC	Apply
CO6	Explain the use of industrial robots	Understand

iv) **SYLLABUS**

Basic concepts of control systems - Process control block diagram – Control system evaluation – Transfer function - Modeling of physical systems – Response analysis of first order and second order systems - Linearisation - Time domain and frequency domain specifications – Transportation lag – Concept of stability – On-off, P, PI and PID Controllers – Ziegler Nichol's tuning method - Advanced control strategies – Process Identification -Automation architecture - Actuators - Control Valves- Discrete state process control - Programmable Logic Controllers - Ladder programming – Industrial robots – Robot subsystems, classification and Applications.

v) **(a) TEXT BOOKS**

1. Coughanowr, D. R., LeBlanc, S. "Process Systems Analysis and Control", 3rd edition, McGraw-Hill (2008). TTR
2. C. D. Johnson, "Process control Instrumentation Technology," Pearson Education, Eighth Edition, 2006, PHI, 8th Edition, 2013.
3. William L. Luyben, 'Process Modelling, Simulation and Control for Chemical Engineers,' Mc- Graw Hill, 2nd edition 1989.
4. Surekha Bhanot, "Process Control - Principles & Applications," Oxford University Press, 2008
5. S. K. Saha, 'Introduction to Robotics', McGraw Hill Education Pvt. Ltd., 2nd edition, 2014
6. Norman S. Nice, 'Control Systems Engineering', 6th edition 2011

(b) REFERENCES

1. Stephanopoulos, G. "Chemical Process Control: An Introduction to Theory and Practice", Pearson Education (1984), PHI, 2006.
2. B. Wayne Bequette, "Process control, modeling, Design and simulation", Prentice Hall of India (P) Ltd., 2003
3. Huges T, 'Programmable Controllers', ISA press, 4th Edition Illustrated, 2005.
4. Considine D.M., Process Instruments and Controls Handbook, Second Edition, McGraw, 1999.
5. G. Liptak, 'Handbook of Process Control,' 1996
6. K. Krishnaswamy, "Process Control", New Age International, 2007.
7. Patranabis D., "Principles of Process Control", Tata McGraw Hill, New Delhi.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introductory concepts:** Process Control principles – self regulated system, Human aided control, Automatic control, Servomechanisms, Discrete state control systems, Open loop and closed loop systems, Process Control block diagram, Control System evaluation – objective, stability, steady state and transient regulations, Evaluation criteria. Concept of transfer function, Poles and zeros, Type and order, Standard test signals.	**12**
II	**Time domain specifications** – Delay time, Rise time, Peak time, Peak Overshoot, Settling time.Linear open loop systems: Response of first order systems: Step response, impulse response. Physical examples of first order systems: Modelling of liquid level control, mixing process and heating process as first order systems, Concept of linearization of system model. **Response of first order systems in series** – Non-interacting and interacting systems for liquid level control. Response analysis of second order systems – Undamped, underdamped, critically damped and overdamped systems. **Frequency response** – Frequency domain specifications – Resonant Peak, Resonant Frequency, Bandwidth, Gain margin and Phase margin. Modelling of transportation lag	**12**
III	**Linear Closed loop systems:** Closed loop system - Characteristic equation, Concept of stability, Location of poles and stability, Routh's stability test. Study of ON-OFF control, P, PI and PID controllers, Ziegler Nichol's method for PID tuning. **Advanced Control strategies**: Cascade control, Feedforward control, Ratio Control, Smith Predictor control, Selective control, Model Reference Adaptive Control.	**12**
IV	**Process Identification and automation:** Direct methods – Time domain eyeball fitting of Step test data, Direct sine wave testing.	**12**

	Architecture of Industrial Automation Systems: Final control operation – Actuators and Control elements. Actuators – Construction, Principle, Advantages and disadvantages of Hydraulic, Pneumatic and Electrical actuators. Control elements – Control Valves construction and principle, Types –quick opening, linear, equal percentage, Classification	
V	**Discrete state process control:** Programmable Logic Controllers – architecture and operation, Comparison of PLC & PC, Relays and Ladder Logic, Ladder Programming – Basic symbols used, Realization of AND, OR logic, Concept of latching. Introduction to Timer/Counters- Simple ladder programs **Industrial Robots:** Robot Subsystems – Motion, Recognition and Control subsystems, Classification of Robots – Based on work envelope, actuation and motion control methods, Industrial Applications – Material handling, welding, spray painting, machining, assembling	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2H30B	MATHEMATICS FOR MACHINE LEARNING	VAC	4	0	0	4	2022

i) **PRE-REQUISITE:** A sound background in higher secondary school Mathematics.

ii) **COURSE OVERVIEW**: The goal of this course is to introduce students to make use of the concepts, rules and results about linear equations, matrix algebra, vector spaces, eigenvalues & eigenvectors and orthogonality & diagonalization to solve computational problems. This course will enable students to perform calculus operations on functions of several variables and matrices, including partial derivatives and gradients. It also aims to expose students to train Machine Learning Models using unconstrained and constrained optimization methods.

iii) **COURSE OUTCOMES**

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

CO1	Make use of the concepts, rules and results about linear equations, matrix algebra, vector spaces, eigenvalues & eigenvectors and orthogonality & diagonalization to solve computational problems.	Apply
CO2	Perform calculus operations on functions of several variables and matrices, including partial derivatives and gradients.	Apply
CO3	Utilize the concepts, rules and results about probability, random variables, additive & multiplicative rules, conditional probability, probability distributions and Bayes' theorem to find solutions of computational problems.	Understand
CO4	Train Machine Learning Models using unconstrained and constrained optimization methods.	Apply

iv) **SYLLABUS**

Matrices, Solving Systems of Linear Equations, Vector Spaces, Linear Independence, Basis and Rank. Matrix Representation of Linear Mappings, Image and Kernel. Norms, Inner Products, Orthonormal Basis, Orthogonal Complement, Projection into One Dimensional Subspaces, Eigenvalues and Eigenvectors, Matrix Approximation.
Differentiation of Univariate Functions - Gradients of Vector Valued Functions, Gradients of Matrices, Back propagation and Automatic Differentiation.
Discrete and Continuous Probabilities, Sum Rule, Product Rule, and Bayes' Theorem.
Summary Statistics and Independence – Gaussian distribution - Conjugacy and the Exponential Family. Gradients in Deep Network, Automatic Differentiation.
Higher Order Derivatives - Linearization and Multivariate Taylor Series. Constrained Optimization and Lagrange Multipliers. Linear Programming - Quadratic Programming.

v) **(a) TEXT BOOKS**

1) Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong, Cambridge University Press publication,2020 (freely available at https://mml - book.github.io)

(b) REFERENCES

1) Linear Algebra and Its Applications, 4th Edition by Gilbert Strang.
2) Linear Algebra Done Right by Axler, Sheldon, 2015 published by Springer.

3) Introduction to Applied Linear Algebra by Stephen Boyd and Lieven Vandenberghe, 2018 published by Cambridge University Press.
4) Convex Optimization by Stephen Boyd and Lieven Vandenberghe, 2004 published by Cambridge University Press.
5) Pattern Recognition and Machine Learning by Christopher M Bishop, 2006, published by Springer
6) Learning with Kernels – Support Vector Machines, Regularization, Optimization, and Beyond by Bernhard Scholkopf and Smola, Alexander J Smola, 2002, published by MIT Press
7) Information Theory, Inference, and Learning Algorithms by David J. C MacKay, 2003 published by Cambridge University Press
8) Machine Learning: A Probabilistic Perspective by Kevin P Murphy, 2012 published by MIT Press.
9) The Nature of Statistical Learning Theory by Vladimir N Vapnik, 2000, published by Springer.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Linear Algebra:** Introduction to vectors and matrices, Vector and matrix operations (addition, scalar multiplication, dot product, cross product), Matrix inversion, transpose and determinant, Eigenvalues and eigenvectors, Orthogonality, Singular Value Decomposition (SVD), Systems of Linear Equations, N-Dimensional Vector, Distance between Vectors Projection onto a plane and Hyperplane, Vector Space, Subspace, Basis, Rank and Dimension. Gradient, Divergence and Curl. Application of Linear Algebra in ML algorithms.	**14**
II	**Calculus**: Functions, Types of Functions and Chain Rule, Differentiation of Univariate Functions, Partial Differentiation and gradient vectors, Backpropagation and automatic differentiation, Linearization and Multivariate Taylor Series, Integration and its applications, Multivariate calculus (E.g. Jacobian matrix, Hessian matrix), Lagrange multipliers, Calculus-based optimization algorithms (E.g. Newton's method), Convex sets, convex functions and its properties.	**12**
III	**Probability and Distributions:** Probability Definition, Joint and Conditional Probability, Construction of a Probability Space - Discrete and Continuous Probabilities, Sum Rule, Product Rule, and Bayes' Theorem, Random Variables and Probability Distributions, Probability distribution function, Application of Probability in Classification and Regression algorithms (Eg:Naive Bayes). Statistical classification techniques (Linear Discriminant Analysis (LDA) and Quadratic Discriminant Analysis (QDA)	**14**
IV	**Applied Statistics:** Descriptive Statistics - Mean, Median and Mode, Variance and standard deviation. Measures of Central tendency, Dispersion and Correlation, Sampling distributions and Central Limit Theorem, Hypothesis Testing, Types of tests: t-test of mean, z-test of proportion, ANOVA test of variance.	**8**
V	**Optimization**: Introduction to optimization problems, Unconstrained and Constrained optimization, Numerical Optimization in Machine Learning,	**12**

	Optimization Using Gradient Descent - Gradient Descent with Momentum, Stochastic Gradient Descent. Lagrange Multipliers. Convex and Concave Optimization, Newton's method and quasi-Newton methods, Applications of optimization in machine learning (Eg: parameter estimation, model fitting)	
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2H30C	MICROGRIDS	VAC	4	0	0	4	2022

i) PRE-REQUISITE: NIL

ii) COURSE OVERVIEW: This course illustrates the concept of distributed generation, analyse the impact of grid integration and helps to study concept of Microgrid and its configuration.

iii) COURSE OUTCOMES

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

CO 1	Outline the conventional power generation.	Understand
CO 2	Explain the concept of distributed generation and installation.	Understand
CO 3	Classify the grid integration system with conventional and non-conventional energy sources.	Understand
CO 4	Explain dc and ac micro grid	Understand
CO 5	Interpret power quality issues and control operation of micro grid	Understand

iv) SYLLABUS

Introduction - Conventional power generation: advantages and disadvantages. Distributed Generations - Concept of distributed generations, topologies, selection of sources, regulatory standards/framework, Standards for interconnecting Distributed resources to electric power systems. Impact Of Grid Integration:- Requirements for grid interconnection, limits on operational parameters. Impact of grid integration with NCE sources on existing power system.

Basics of a Microgrid - Concept and definition of microgrid. Power Electronics interfaces in DC and AC microgrids.Control And Operation Of Microgrid:- Modes of operation and control of microgrid. Introduction to smart microgrids.

v) (a) TEXT BOOKS

1) Amirnaser Yezdani, and Reza Iravani, “Voltage Source Converters in Power Systems:Modeling, Control and Applications”, IEEE John Wiley Publications, 2009.
2) DorinNeacsu, “Power Switching Converters: Medium and High Power”, CRC Press, Taylor& Francis, 2006.

(b) REFERENCES

1) Chetan Singh Solanki, “Solar Photo Voltaics”, , PHI learning Pvt. Ltd., New Delhi, 2009
2) J.F. Manwell, J.G “Wind Energy Explained, Theory Design and Applications,”. McGowan Wiley publication, 2nd Edition, 2009.
3) D. D. Hall and R. P. Grover, “Biomass Regenerable Energy”, , John Wiley, New York, 1987.
4) John Twidell and Tony Weir, “Renewable Energy Resources”, Taylor and Francis Publications, Second Edition, 2006.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Conventional power generation: advantages and disadvantages, Energy crises, non-conventional energy (NCE) resources: review of Solar PV, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources. Concept of microgrid.	12
II	**DISTRIBUTED GENERATIONS (DG):** Concept of distributed generations, topologies, selection of sources, regulatory standards/framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547. DG installation classes, security issues in DG implementations. Energy storage elements: Batteries, ultra-capacitors, flywheels. Captive power plants.	12
III	**IMPACT OF GRID INTEGRATION:** Requirements for grid interconnection, limits on operational parameters,: voltage, frequency, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.	12
IV	**BASICS OF A MICROGRID:** Concept and definition of microgrid, microgrid drivers and benefits, review of sources of microgrids, typical structure and configuration of a microgrid, AC and DC microgrids, Power Electronics interfaces in DC and AC microgrids.	12
V	**CONTROL AND OPERATION OF MICROGRID:** Modes of operation and control of microgrid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication-based techniques, microgrid communication infrastructure, Power quality issues in microgrids, regulatory standards, Microgrid economics, Introduction to smart microgrids.	12
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2H30D	ELECTRIC VEHICLE TECHNOLOGY	VAC	4	0	0	4	2020

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

The main goal of this course is to expose the students to the fundamental concepts and trends in electric vehicles and hybrid electric vehicles and it also discusses how to choose proper energy storage systems for vehicle applications. It gives an insight into the electric propulsion unit and its control for application of electric vehicles. It also intends to deliver various energy management strategies, charging technologies and standards used in vehicle networks.

iii) COURSE OUTCOMES

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

CO 1	Apply the concept of hybrid electric vehicles in determining the vehicle performance.	Understand
CO 2	Explain the configuration and control of motor drives used in electric propulsion systems.	Understand
CO 3	Compare the proper energy storage systems for vehicle applications.	Understand
CO 4	Choose the suitable system components for developing an electric and hybrid vehicle.	Apply
CO 5	Explain various communication protocols and technologies used in hybrid and electric vehicles.	Understand

iv) SYLLABUS

Conventional Vehicles, Basics of vehicle performance, Basic Architecture of hybrid traction, Power flow control.

Electric Propulsion unit, Configuration and control of DC motor drives, Induction Motor drives, PM and SRM motor drives.

Energy Storage Requirements in Hybrid and Electric Vehicles, Battery, fuel cell, flywheel and supercapacitor-based energy storage.

Design of electric and hybrid electric vehicle, sizing of components.

Communication Systems, Energy Management Strategies, EV charging technologies and policies.

v) (a) TEXT BOOKS

1) Iqbal Husain: *Electric and Hybrid vehicles: Design Fundamentals,* CRC press, 2003.
2) Ehsani M., *Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design*, CRC Press, 2005.
3) Gianfranco Pistoia, *Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure and the Market,* Elsevier, 2010.
4) Chan C. C. and Chau K. T., *Modern Electric Vehicle Technology,* OXFORD University Press, 2001.

(b) REFERENCES

1) James Larminie, John Lowry, *Electric Vehicle Technology Explained*, Wiley, 2003.
2) Fuhs A. E., *Hybrid Vehicles and the Future of Personal Transportation,* CRC Press, 2009.

3) Chris Mi , Abul Masrur M., *Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives,* Second Edition, John Wiley & Sons Ltd, 2017.
4) Sheldon S. Williamson, *Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles*, Springer, 2013.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Electric and Hybrid Electric Vehicles**: Hybrid and Electric Vehicles Components, Power transmission path, Social and environmental impacts of Electric and Hybrid vehicles. **Basics of Vehicle Propulsion:** Dynamic equation, Maximum tractive effort, Vehicle Power Plant and Transmission characteristics, vehicle performance factors. **Hybrid Electric Drive-trains:** Architecture of Hybrid Electric Drive Trains, various topologies, Power flow control in Series Hybrid Electric Drive Trains and Parallel hybrid electric drive trains.	**12**
II	**Electric propulsion:** Electric components used in electric and hybrid drives, Classification of Electric Motors in EV, DC motor drives and speed control, Induction motor drives, Permanent Magnet Motor Drives, BLDC Drive, Switched Reluctance Motor Drive for Electric Vehicles, Configuration, and control of Drives.	**12**
III	**Energy Storage for EV and HEV:** Energy storage requirements, Battery parameters, Battery based energy storage and its analysis, Li-ion batteries, Cell balancing and cooling, Battery Management System, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.	**12**
IV	**Design of Electric and Hybrid Electric Vehicles:** Sizing of major components - Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology. **Case studies:** Performance analysis of a Hybrid Electric Vehicle (HEV), Performance analysis of a Battery Electric Vehicle (BEV).	**12**
V	**Communications**: In vehicle networks - CAN **Energy management strategies:** Energy Management Strategies used in Electric and Hybrid Vehicles, Concept of V2G, G2V, V2B, V2V. **EV Charging Technologies:** Standards, Conductive and Inductive charging methods, EV Charging infrastructure - Policy, Impacts of integration of EVs in Smart Grid.	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

SEMESTER 6

Course Code	Course Name	L-T-P	Credit
EL2H30E	Introduction to Navigation and Trajectory planning	3-1-0	4
EL2H30F	Machine Learning Programming	3-1-0	4
EL2H30G	Distributed Generation and Smart Grid	3-1-0	4
EL2H30H	Automotive Electronic systems	4-0-0	4

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2H30E	INTRODUCTION TO NAVIGATION AND TRAJECTORY PLANNING	VAC	3	1	0	4	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW: The main goal of this course is to present the fundamentals of basic ideas of Robotics and to give insight into the Navigation, Guidance,Trajectory and Control.This course discusses about the various aspects of robotics and their navigation, guidance and control schemes.

iii) COURSE OUTCOMES

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

CO 1	Understand the basic concepts of autonomous navigation and path planning.	Understand
CO 2	Apply a suitable navigation and path planning algorithm for a specific task	Apply
CO 3	Apply a suitable method for obstacle avoidance for a specific task	Apply
CO 4	Apply different path planning and trajectory planning techniques	Apply
CO5	Apply algorithms in real-world applications using Modern Simulation Tools.	Apply

iv) SYLLABUS

Introduction to Autonomous Navigation and Path Planning-Definition and basic concepts of autonomous navigation and path planning-Introduction to various techniques and algorithms used for navigation and path planning-Navigation Techniques and Algorithms-Obstacle Avoidance Techniques-Workspace Analysis and Trajectory Planning-Work Envelope of different Robots-Applications-Optimal Path Planning Techniques and Trajectory Planning-Introduction to Robot Operating System (ROS), and GAZEBO, Case Studies and Examples

v) (a) TEXT BOOKS

1) Ashitava Ghosal, 'Robotics Fundamental Concepts and Analysis', Oxford University Press.
2) Robin R. Murphy, 'Introduction to AI Robotics', Prentice-Hall India, 2005.
3) Janakiraman P. A., 'Robotics and Image Processing', Tata McGraw Hill, New Delhi, 1995
4) Steven M. LaValle, Planning Algorithms Hardcover – Illustrated, 29 May 2006
5) J-P. Laumond, Robot Motion Planning and Control, 1998
6) K. S. Fu, R. C. Gonzalez, and C. S. G. Lee, "ROBOTICS – Control, Sensing, Vision, and Intelligence", McGraw-Hill Book Company.

(b) REFERENCES

1) Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, Introduction to Autonomous Mobile Robots", Bradford Company Scituate, USA, 2004.
2) J.J. Graig, "Introduction to Robotics – Mechanics and Control", 2nd edition, Pearson Education, Inc
3) S.R. Deb, 'Robotics Technology and Flexible Automation', Tata McGraw-Hill, New Delhi, Fourth Edition, 2009.
4) Yoran Kaen, 'Robots for Engineering', Tata McGraw-Hill

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Autonomous Navigation and Path Planning,** Definition and basic concepts of autonomous navigation and path planning, Applications of autonomous navigation and path planning, Sensors and odometry, Introduction to various techniques and algorithms used for navigation and path planning, State estimation methods (Kalman filter, unscented Kalman filter, particle filtering)	**12**
II	Camera modeling and calibration, structure from motion, visual motion estimation. Navigation Techniques and Algorithms -Sensor-based navigation -Dead reckoning -Beacon-based navigation -Landmark-based navigation	**12**
III	Obstacle Avoidance Techniques - Potential field method - Virtual force field method - Artificial potential fields method	**11**
IV	Workspace Analysis and Trajectory Planning-Work Envelope of different autonomous vehicle-Applications-Continuous Path Motion-Interpolated Motion-Straight Line Motion Optimal Path Planning Techniques and Trajectory Planning -Dijkstra's algorithm-A* algorithm-Probabilistic Road map method -Trajectory planning for Autonomous Vehicle	**15**
V	Introduction to Robot Operating System (ROS), and GAZEBO, Case Studies and Examples	**10**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2H30F	INTRODUCTION TO MACHINE LEARNING	VAC	3	1	0	4	2022

i) PRE-REQUISITE: Fundamentals of Python, Machine learning

ii) COURSE OVERVIEW: This course some of the core ideas in machine learning, data science that will help them go from a real-world business problem to a first-cut, working, and deployable ML solution to the problem.

iii) COURSE OUTCOMES

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

CO1	Understand the need for Machine Learning and the relevance of Python programming in ML.	Understand
CO2	Apply the various learning methods and ML algorithms using Python Programming	Apply
CO3	Explain Featurization and Model Tuning for various algorithms in Machine Learning	Understand
CO4	Explain Collaborative Filtering and types of Recommendation systems in Machine Learning	Understand

iv) SYLLABUS

Machine Learning with Python - Basics, need for machine learning, learning in machines, machine learning model, challenges in machine learning, applications of machine learning.
Introduction to Python - strength and weakness, Python and data science, components of python ML ecosystem. Python-scikit learn - installation, mglearn.
Supervised learning, Unsupervised learning - Clustering Data Representation, linear models and trees, interactions and polynomials, automatic feature selection, types.
Featurization Engineering, Model Tuning and Recommendation systems in Machine Learning.

v) (a) TEXT BOOKS

1) Andreas C. Müller, Sarah Guido, Introduction to Machine Learing by Python, First Edition, O'Reilly Media Publishers, 2016.
2) Sebastian Raschk Vahid Mirjalili, Python Machine Learning, Second Edition, Ingram short title Publishers, 2017.

(b) Reference Books

1) Abhishek VijayVargia, Machine Learning with Python, BPB Publications, 2018.
2) Manaranjan Pradhan U Dinesh Kumar, Machine Learning using Python, Wiley Publications, 2019.
3) Dr. Manish H Attal, Machine Learning and Python, Bluerose Publishers,2022.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Python**: Numpy and Pandas - Numpy Accessing Entries. Saving and loading numpy arrays in local systems, Series and Dataframes, Accessing and modifying, Combining Data Frames, Functions, Saving and Loading data-frames, Essential libraries and tools.	**10**

	Data Visualization using Python - Plots and graphs, Exploratory Data Analysis (EDA) techniques, Visualization with Matplotlib and Seaborn.	
II	**Supervised learning**- Classification and Regression Algorithms, Linear and Logistic Regression, k-nearest neighbors, Naive Bayes classifiers, Decision trees, kernelized SVM. Case studies and Application of Supervised learning Algorithms using Python Programming.	**13**
III	**Unsupervised learning**: Clustering- K-means clustering, Dynamic clustering, comparison and evaluation of clustering algorithms. Hierarchical Clustering & Principal Component Analysis (PCA) for dimensionality reduction. Case studies and Application of Unsupervised learning Algorithms using Python Programming.	**13**
IV	**Featurization & Model Tuning :** Feature Engineering and Cross-Validation - Techniques for obtaining and transforming data, Handling outliers and missing values, K-fold cross-validation, Bootstrap sampling Model Performance Measures & Hyperparameter tuning - Assessing model complexity vs. error, Iterative model evaluation and tuning, Validation set, up-sampling and down-sampling techniques, Grid search and randomized search for hyperparameter tuning.	**12**
V	**Recommendation Systems**:Popularity Based Model - Introduction to Recommendation systems and its applications, Types of recommendation systems, Popularity based recommendation system, Content-Based recommender, Similarity measures. Singular Value Decomposition & Collaborative Filters-Matrix factorization, Market Basket analysis Support, Confidence and Lift, Collaborative filtering. Precision, Recall & Accuracy	**12**
	Total hours (Approx.)	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2H30G	DISTRIBUTED GENERATION AND SMART GRID	VAC	3	1	0	4	2022

i) **PRE-REQUISITE: Nil**

ii) **COURSE OVERVIEW**: To develop a conceptual introduction to various distributed generation systems, micro grids, smart grids and their control

iii) COURSE OUTCOMES

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

CO1	Explain various distributed generation systems	Understand
CO	Explain the micro grids and their control schemes	Understand
CO3	Explain Protection issues for Micro grids and introduction to smart grid	Understand
CO4	Apply Smart energy efficient end use devices and its methodologies in demand side management	Apply
CO5	Explain various developments happening in the field of Smart Grids	Understand

iv) SYLLABUS

Introduction to distributed generation and smart grids - Distributed Energy Resources – Micro Grids and their control – Protection issues for Microgrids - Smart Grids: Components – NIST Reference architecture – Smart meters - Wide Area Measurement System (WAMS), Phase Measurement Unit (PMU) - demand response- Demand Side Management - Smart Substations, HAN, NAN, SANET, Cloud computing in smart grid – Power Quality issues with smart grid

v) (a) TEXT BOOKS

1) Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, ISBN: 978-0-47062761-7, Wiley
2) James Momoh, Smart Grid: Fundamentals of Design and Analysis, ISBN: 978-0-470-889398, Wiley
3) R. C. Durgan, M. F. Me Granaghen, H. W. Beaty, “Electrical Power System Quality”, McGraw-Hill

(b) REFERENCES

1) Remus Teodorescu, Marco Liserre, Pedro Rodriguez, Grid Converters for Photovoltaic and Wind Power Systems, ISBN: 978-0-470-05751-3, Wiley
2) S. Chowdhury, S.P. Chowdhury and P. Crossley, Microgrids and Active Distribution Networks, ISBN 978-1-84919-014-5, IET, 2009.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Distributed generation – Introduction - Integration of distributed generation to Grid – Concepts of Micro Grid - Typical Microgrid configurations - AC and DC micro grids - Interconnection of Microgrids - Technical and economical advantages of Microgrid-Challenges and disadvantages of Microgrid	**10**

	development Smart Grid: Evolution of Electric Grid - Definitions and Need for Smart Grid, Opportunities, challenges and benefits of Smart Grids	
II	Distributed energy resources: Introduction - Combined heat and power (CHP) systems - Solar photovoltaic (PV) systems – Wind energy conversion systems (WECS) - Small-scale hydroelectric power generation - Storage devices: Batteries: Lead acid, nickel metal hydride, and lithium ion batteries , ultra-capacitors, flywheels Control of Microgrids: Introduction to Central Controller (CC) and Microsource Controllers (MCs) - Control functions for microsource controller, Active and reactive power control, Voltage control, Storage requirement for fast load tracking, Load sharing through power-frequency control .	**12**
III	Protection issues for Microgrids: Introduction, Islanding, Different islanding scenarios, Major protection issues of standalone Microgrid - Impact of DG integration on electricity market, environment, distribution system, communication standards and protocols. Smart Grid: Components – NIST Smart Grid Reference Architecture, Introduction to Smart Meters, Electricity tariff – one part tariff, two tariff and maximum demand tariff - Dynamic pricing: time-of-use (TOU) pricing, critical-peak pricing (CPP) and Real Time Pricing-Automatic Meter Reading(AMR), Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation. Intelligent Electronic Devices (IED) and their application for monitoring & protection, Wide Area Measurement System (WAMS), Phase Measurement Unit (PMU).	**12**
IV	Smart energy efficient end use devices-Smart distributed energy resources- Load Curves-Load Shaping Objectives-Methodologies - Peak load shaving - Energy management-Role of technology in demand response- Demand Side Management – Numerical Problems. Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood-Area Networks (NANs), Sensor and Actuator Networks (SANETs).	**12**
V	Smart Substations, Substation Automation, IEC 61850 Substation Architecture, Feeder Automation. 7 20% VI Cloud computing in smart grid: Private, public and Hybrid cloud. Cloud architecture of smart grid. Power quality: Introduction - Types of power quality disturbances - Voltage sag (or dip), transients, short duration voltage variation, Long duration voltage variation, voltage imbalance, waveform distortion, and voltage flicker - Harmonic sources: SMPS, Three phase power converters, arcing devices, saturable devices, fluorescent lamps, harmonic indices (THD, TIF, DIN, C – message weights) Power quality aspects with smart grids.	**14**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2H30H	AUTOMOTIVE ELECTRONIC SYSTEMS	VAC	2	1	0	3	2022

i) PRE-REQUISITE: Basic Electrical Engineering and Basic Electronics Engineering

ii) COURSE OVERVIEW: The aim of this subject is to offer the students a general understanding of various automotive electronic systems used in automobiles.

- Explain the construction of battery used in automotive vehicles.
- Describe the construction and working of D.C. generator, alternator, cranking motor.
- Explain the working of ignition systems along with trouble shooting.
- Discuss the various parts of lighting system.
- Use transducers and sensors in electronic circuits.

iii) COURSE OUTCOMES

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

CO 1	Explain constructional details and working of various batteries used in automotive vehicles	Understand
CO 2	Illustrate the construction and working of starter motor and alternator	Understand
CO 3	Explain the construction and working of battery ignition system and also working of electronic fuel injection system	Understand
CO 4	Explain the different types of components that make up the lighting systems.	Understand
CO 5	Explain the working of various sensors used in automobiles and automotive wiring	Understand

iv) SYLLABUS

Principle of lead acid battery & constructional details-Capacity Rating, Battery charging methods, Battery tests. Developments in storage. Charging system: Working and constructional details of Alternators Starting system: Requirement of starter motor -Starter drive mechanisms. Battery coil and Magneto ignition system, Centrifugal and Vacuum advance mechanisms, Spark plugs, constructional details and types. Electronically assisted ignition system; Non-contact triggering devices - Electronic fuel injection system overview. Lighting, Instrumentation types -Lamp construction and working details-Electromagnetic Compatibility and its suppression techniques, Hybrid Vehicles. Cruise control system, traction control system, Transmission control system. Sensors and applications in Automobile, Actuators. Introduction to internet of things (IOT) and its automotive applications.

v) (a) TEXT BOOKS

1) Kohli.P.L. Automotive Electrical Equipment, Tata McGraw-Hill Co Ltd

2) Tom Denton, “Automobile Electrical and Electronic Systems”, Elsevier Butterworth-Heinemann, 2004.

(b) REFERENCES

1) Al Santini, Automotive Electricity and Electronics, Cengage Learning, 2013AUTOMOBILE ENGINEERING

2) Robert Bosch, Automotive Handbook, Bently Publishers,2004

3) William B. Ribbens, Norman P. Mansour, Understanding automotive electronics, Newnes, 2003
4) Jim Horner, Automotive Electrical HandBook, Penguin, 1986
5) Barry Hollembeak, Automotive Electricity & Electronics, Cengage Learning,2010

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Batteries:** Principle of lead acid battery & constructional details, Effect of temperature on electrolyte, Capacity Rating, Battery charging methods, Battery tests. Developments in storage: Nickel metal hydride battery, Lithium-ion battery, Fuel cells, Ultra capacitors..	**8**
II	**Charging system:** Working and constructional details of Alternators (single and three phase), Rectification, voltage regulation, current regulation, Charging circuit for 3 phase alternators. **Starting system:** Requirement of starter motor; Starter Motor types, construction and characteristics, Starter drive mechanisms, Starting circuit, Starter Switches.	**8**
III	**Battery coil and Magneto ignition system:** Centrifugal and Vacuum advance mechanisms, Spark plugs, constructional details and types. Electronically assisted ignition system; non-contact triggering devices - Fully electronic ignition System, Capacitive Discharge Ignition, Distributor-less ignition, Programmed ignition. **Electronic fuel injection system overview:** D jetronic, K jetronic and L jetronic fuel injection; Injections schemes–Single point, Multi point, Sequential, Direct injection, Common rail direct injection, Gasoline direct injection, Supercritical injection.	8
IV	**Lighting**: Types of headlights, headlight reflectors, headlight lenses, indicator lamp details, lighting circuit, projector headlights; Horn and wiper mechanisms. Head Lamp and Indicator Lamp construction and working details, Focusing of head lamps, Anti– Dazzling and Dipper Details, Automotive Wiring. Electromagnetic Compatibility and its suppression techniques, Hybrid Vehicles.	**9**
V	**Instrumentation**: Speedometer, Fuel Level Indicator, Oil Pressure and Coolant Temperature Indicators, Display devices – LED, LCD, VFD, Onboard diagnostics (OBD), OBD – II **Control System:** Cruise control system, Antilock braking system, electronic suspension system, electronic steering control, traction control system, Transmission control system **Sensors and applications in Automobile:** Pressure sensors, Temperature sensors, Position sensors, Lambda sensor, Air flow sensor, Wheel speed sensor, Knock sensor, Optical sensors. Actuators: Solenoids, Stepper motors, Relays, Piezoelectric. Introduction to internet of things (IOT) and its automotive applications.	**12**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours