SYLLABUS (S5, S6)

B. Tech.

ELECTRONICS AND COMPUTER ENGINEERING (ER)

2024 SCHEME

FIFTH SEMESTER (July-December)														
Sl. No.	Slot	Course Code	Course Type	Course Category	Course Title (Course Name)	Credit Structure				SS	Total Marks		Credits	Hrs./ Week
						L	T	P	R		CIA	ESE		
1	A	24SJPCERT501	PC	PC	Digital Signal Processing	3	1	0	0	5	40	60	4	4
2	B	24SJPCERT502	PC	PC	Theory of Computation	3	1	0	0	5	40	60	4	4
3	C	24SJPCERT503	PC	PC	Microcontrollers and Interfacing	3	0	0	0	4.5	40	60	3	3
4	D	24SJPBERT504	PC-PBL	PB	Database Management Systems	3	0	0	1	5.5	60	40	4	4
5	E	24SJPEERT52N	PE	PE	PE-2	3	0	0	0	4.5	40	60	3	3
6	I*	24SJICHUM506	HMC	IC	Constitution of India (MOOC)	-	-	-	-	2	-	-	1	-
7	L	24SJPCERL507	PCL	PC	Digital Signal Processing Lab	0	0	3	0	1.5	50	50	2	3
8	Q	24SJPCERL508	PCL	PC	Database Management Systems Lab	0	0	3	0	1.5	50	50	2	3
9	R/M/H		VAC		Remedial/Minor/Honours Course	3	1	0	0	5			4*	4*
	S_5/ S_6	Industrial Visit (Maximum 6 Days are permitted, Not Exceeding more than 4 Working Days) /Industrial Training												
Total										**30/ 35**			**23/27***	**24/28***

PROGRAM ELECTIVE 2: 24SJPEERT 52N

SLOT	COURSE CODE	COURSES	L-T-P-R	HOURS	CREDIT
E	24SJPEERT 521	Wireless Sensor Networks	3-0-0-0	3	3
	24SJPEERT 522	CMOS VLSI Design	3-0-0-0		3
	24SJPEERT 523	Sensors and actuators	3-0-0-0		3
	24SJPEERT 524	Cloud Computing	3-0-0-0		3
	24SJPEERT 526	Python for Machine Learning	3-0-0-0		3
	24SJPEERT 525	Computational Fundamentals for Machine Learning	3-0-0-0		5/3

SIXTH SEMESTER (January-June)														
Sl. No.	Slot	Course Code	Course Type	Course	Course Title (Course Name)	Credit Structure				SS	Total Marks		Credits	Hrs./ Week
						L	T	P	R		CIA	ESE		
1	A	24SJPCERT601	PC	PC	Operating Systems	3	1	0	0	5	40	60	4	4
2	B	24SJPCERT602	PC	PC	Data Communication and Networking	3	0	0	0	4.5	40	60	3	3
3	C	24SJPEERT63N	PE	PE	PE-3	3	0	0	0	4.5	40	60	3	3
4	D	24SJPBERT604	PC-PBL	PB	Embedded Systems and IoT	3	0	0	1	5.5	60	40	4	4
5	F	24SJGYEST605	ESC	GC	Design Thinking and Product Development (Group Specific Syllabus)	2	0	0	0	3	40	60	2	2
6	O	24SJOEERT61N /24SJ IEERT61N	OE/ ILE	)E/IE	OE/ILE-1	3	0	0	0	4.5	40	60	3	3
7	L	24SJPCERL607	PCL	PC	Embedded Systems and IoT Lab	0	0	3	0	1.5	50	50	2	3
8	P	24SJPCERP608	PWS	PC	Mini Project: Socially Relevant Project	0	0	3	0	3	50	50	2	3
9	R/M H		VAC		Remedial/Minor/Honours Course	3	0	0	0	4.5			3*	3*
	S5/ S6	Industrial Visit (Maximum of 6 Days are permitted, Not Exceeding more than 4 Working Days) /Industrial Training												
Total										**32/ 36**			**23/26***	**25/28***

PROGRAM ELECTIVE 3: 24SJPEERT 63N

SLOT	COURSE CODE	COURSES	L-T-P-R	HOURS	CREDIT
C	24SJPEERT 631	Network and Linear Control Systems	3-0-0-0	3	3
	24SJPEERT 632	Micro-Electro-Mechanical-Systems	3-0-0-0		3
	24SJPEERT 633	Foundations of Data Science	3-0-0-0		3
	24SJPEERT 634	Compiler Design	3-0-0-0		3
	24SJPEERT 636	Algorithm Analysis and Design	3-0-0-0		3
	24SJPEERT 635	Design & Analysis of Algorithms	3-0-0-0		5/3

SEMESTER 5

ELECTRONICS AND COMPUTER ENGINEERING

SEMESTER S5

DIGITAL SIGNAL PROCESSING

Course Code	24SJPCERT501	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To understand the various design techniques and realization methods of FIR and IIR filters.
2. To describe signals mathematically and understand how to perform mathematical operations on signals.
3. To understand the analytical tools such as Discrete Time Fourier Transforms, Discrete Fourier Transforms, Fast Fourier Transforms and Z-Transforms required for digital signal processing.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Signals, Systems and Digital Signal Processing:** Continuous and Discrete Time Signals, Generation of Discrete Time Signals – Sampling, Elementary Discrete Time Signals. Classification of signals (Continuous and Discrete) - Periodic and Non-Periodic Signals, Energy and Power Signals, Even and odd signals. Operations on Signals (Continuous and Discrete) - Shifting, Folding, Scaling. Discrete Time Systems-Properties of Discrete Time Systems-Linearity, Time invariance, Causality, Stability. Linear Time Invariant (LTI) Systems – Convolution sum, Impulse response. Difference Equation representation of LTI Systems. Z-transform-Properties of Z-transform, Inverse Z-transform, System Transfer function. Basic Elements of Digital Signal Processing (DSP) System, Typical DSP applications.	11
2	**Frequency Domain Representation of Discrete-Time Signals:** Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT)-Properties. Circular convolution and its relationship with linear convolution; Relationship between DTFT and DFT Efficient Computation of DFT: Fast Fourier Transform (FFT) Algorithms-Radix-2 Decimation in Time (DIT) and Decimation in Frequency (DIF) FFT Algorithms, IDFT computation using Radix-2 FFT Algorithms	10

3	**Design of Digital Filters:** Classification of Digital filters: FIR Filter, IIR Filter. Types of filters-LPF, HPF, BPF, BSF Design of FIR Filters: Linear Phase FIR filters-Symmetric and Anti- symmetric FIR Filters, Gibbs Phenomenon, Design of linear phase FIR filters using Window method (Rectangular, Hamming and Hanning). Design of IIR Digital Filters: Analog Filters (Butterworth), Analog Butterworth Prototype LPF filter design, IIR Filter Design using Impulse Invariance, and Bilinear Transformation, Frequency Transformations in the Analog domain (LPF and HPF only)	**11**
4	**Realization of Digital Filters:** Structures for the realization of Discrete Time Systems: Block diagram and signal flow graph representations of filters. FIR Filter Structures: Linear Phase realization, Direct Form, Cascade Form. IIR Filter Structures: Direct Form, Cascade Form and Parallel Form. **DSP architecture:** Introduction to TMS320C67xx digital signal processor, Functional Block Diagram and Description. Finite word length effects in DSP systems: Introduction (analysis not required), fixed-point and floating- point DSP arithmetic, ADC quantization noise, Round-off error	**12**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Summarize the fundamental concepts of discrete-time signals, systems, digital signal processing and obtain the transfer function of system using Z-transform.	**K2**
CO2	Illustrate the fundamental concepts of DFT and compute DFT and IDFT.	**K2**
CO3	Design FIR filters and IIR filters for the given specifications.	**K3**
CO4	Realize the various FIR and IIR filter structures for given the system function	**K2**
CO5	Explain the architecture ofTMS320C67xxDSPprocessorandthe finite word length effects in DSP systems.	**K2**

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

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

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

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

Text Books				
Sl. No.	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Signal Processing	Proakis J. G. and Manolakis D. G.	Pearson Education	4/e, 2007
2	Discrete-Time Signal Processing	Alan V Oppenheim, Ronald W. Schafer	Pearson Education	3/e, 2014
3	Digital Signal Processing: A Computer Based Approach	Mitra S. K.	McGraw Hill	4/e, 2014

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Signal Processing: A Practical Approach	Ifeachor E.C. and Jervis B. W	Pearson Education	2/e, 2009
2	Understanding Digital Signal Processing	Lyons, Richard G.	Pearson Education	3/e, 2004
3	Digital Signal Processing	Salivahanan S	McGraw - Hill Education	4/e, 2019
4	DSP applications using C and the TMS320C6x DSK.	Chassaing, Rulph	John Wiley & Sons	2003
5	Digital Signal Processing	Vinay K. Ing1e, John G. Proakis	Thomson	2004

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc21_ee28/preview
2	https://nptel.ac.in/courses/117105134
3	https://nptel.ac.in/courses/117102060
4	https://onlinecourses.nptel.ac.in/noc22_ee99/preview

SEMESTER 5

THEORY OF COMPUTATION

Course Code	24SJPCERT502	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Design and implement Java applications that leverage OOP principles to achieve modularity, reusability, and scalability in software development.
2. Understand and apply foundational object-oriented programming concepts in Java, including classes, objects, inheritance, polymorphism, encapsulation, and abstraction.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to formal language theory – Alphabets, Strings, Concatenation of strings, Languages. Regular Languages - Deterministic Finite State Automata (DFA), Nondeterministic Finite State Automata (NFA), Equivalence of DFA and NFA (Proof not required), Regular Grammar (RG), Equivalence of RGs and DFA (Proof not required).	11
2	Regular Expression (RE), Equivalence of REs and DFA (proof not required), Pumping Lemma for regular languages. Closure Properties of Regular Languages, DFA state minimization (Myhill-Nerode Theorem). Applications of MNT.	11
3	Context Free Grammar (CFG), derivation trees and ambiguity. Nondeterministic Pushdown Automata (PDA), Deterministic Pushdown Automata (DPDA). Pumping Lemma for Context-Free Languages (Proof not required), Closure Properties of Context Free Languages.	11
4	Context Sensitive Languages - Context Sensitive Grammar (CSG), Linear Bounded Automata. Turing Machines - Standard Turing Machine, Robustness, Recursive and Recursively Enumerable Languages. Chomsky classification of formal languages.	11

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Design and analyze deterministic and nondeterministic finite automata and understand their equivalence with regular grammars.	**K2**
CO2	Apply regular expressions, finite automata, the pumping lemma, closure properties, and the Myhill-Nerode Theorem for DFA minimization.	**K3**
CO3	Understand and apply context-free grammars, derivation trees, and ambiguity resolution, along with the design and analysis of nondeterministic and deterministic pushdown automata, the pumping lemma, and closure properties of context-free languages.	**K3**
CO4	Understand and apply context-sensitive grammars, linear bounded automata, standard Turing machines, and the classification of formal languages, including recursive and recursively enumerable languages.	**K3**

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

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Automata and Computability	Dexter C. Kozen	Springer	2007

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Automata Theory, Languages, and Computation.	John E Hopcroft, Rajeev Motwani and Jeffrey D Ullman,	Pearson Education	3/e, 2008
2	Introduction To Theory of Computation	Michael Sipser,	Cengage Publishers	2014

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/104/106104148/
2	https://archive.nptel.ac.in/courses/106/104/106104148/
3	https://archive.nptel.ac.in/courses/106/104/106104148/
4	https://archive.nptel.ac.in/courses/106/104/106104148/

SEMESTER S5

MICROCONTROLLERS AND INTERFACING

Course Code	24SJPCERT503	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites	24SJPCERT205, 24SJPCERT402	Course Type	Core

Course Objectives:

The course is designed to enable students to:

1. Understand the architecture, features, memory organization, and I/O ports of the 8051 microcontroller, and differentiate microprocessors from microcontrollers.
2. Describe the 8051 instruction set, addressing modes, assembler directives, and stack operations, and illustrate their use in simple assembly language programs for data manipulation, arithmetic, and program control.
3. Explain the interfacing of external memory with the 8051 microcontroller and describe the functioning of on-chip peripherals including timers/counters, interrupts, and serial communication.
4. Describe the principles of interfacing external I/O devices such as LEDs, switches, displays, and data converters (ADC/DAC), and summarize modern embedded architectures including ARM7 and Raspberry Pi 4 in comparison with the 8051.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction and 8051 Microcontroller Architecture:** **Fundamentals Review:** Review of Digital Data Representation: Bit, Nibble, Byte, Word, Double Word. Concepts of Address, Data and Memory Word Size. System Components: Bus, CPU Bus, System Bus, Tristate Logic and Clock. **Microprocessors:** Definition, Basic Functional Block Diagram, Basic Block Diagram of a Microprocessor-Based System. **Microcontrollers:** Definition, Basic Components. Comparison between Microprocessors and Microcontrollers. Bus System: Concept of Multiplexing	9

	and its Importance in Microprocessor / Microcontroller systems. Demultiplexing (Introductory Concept). **8051 Family:** Introduction to Intel 8051 family (e.g., 8051, 8052, 8031), with a Feature Comparison (e.g., Internal Memory, Timer/Counter) Across Different Family Members. AT89C51 Microcontroller: Features, Pin Diagram, Pin Description, Internal Architecture (Functional Block Diagram), CPU Registers (A, B, PSW, SP, DPTR), Program Counter. Memory Organization: Internal RAM Organization (Register Banks, Bit-Addressable, Scratch Pad RAM), and Internal ROM. Special Function Registers (SFRs) and their Memory Mapping. I/O Ports: Structure and Functions of Ports P0–P3.	
2	**8051 Addressing Modes, Instruction Set, and ALP Fundamentals:** **Addressing Modes:** Definition, Format, and Illustration of all Five Addressing Modes: Immediate, Register, Direct, Register-Indirect, and Indexed addressing modes. **Instruction Set:** Classification and Study of 8051 Instruction Set: Data Transfer, Arithmetic, Logic, Boolean/Bit Manipulation, and Program Control Instructions. **Stack Organization and Operation**: Concept of Stack in 8051, Role of Stack Pointer (SP), Default SP Value (07H), Stack Growth (Increment/Decrement on PUSH/POP), Changing SP Value for Efficient Register Use. **ALP Fundamentals:** Introduction to the Assembly Process (Assembly, Linking, Hex file generation). Essential Assembler Directives (ORG, END, EQU, DB, DW). **Programming Practice:** Writing and executing Simple Assembly Language Programs for Data Manipulation, Block Transfer, and 8-Bit Arithmetic.	**9**
3	**External Memory Interfacing and On-Chip Peripherals of 8051:** **External Memory Interfacing:** Concept of External Program and Data Memory, Interfacing of RAM and ROM With 8051, Connection of Control, Address, and Data Lines. Interfacing Examples. **On-Chip Peripherals:** Overview of Timers/Counters - Basic Timer Modes and Initialization, Concept of Interrupts - Vector Addresses, Interrupt Enable and Interrupt Priority Control, and Basics of Serial Communication Using SBUF and SCON.	**9**
4	**I/O Interfacing: I/O Interfacing (ALP Focus):** Interfacing programs (using ALP) for: LEDs and Switches (Reading digital input and controlling digital output). Interfacing 7-Segment Displays.	**9**

	Data Converters: Introduction to ADC (Analog-to-Digital Converter) and DAC (Digital-to-Analog Converter). Block diagrams and ALP sequence for controlling generic parallel ADC/DAC. **Advanced Architectures:** CISC vs. RISC Architectures. Introduction to ARM Processors – ARM7 Core Fatures and Comparison with 8051/CISC Philosophy. Data-Flow Architecture of ARM7, Programming Model, Operating Modes, General-Purpose and Special-Purpose Registers, and an Introduction to the ARM Interrupt structure. **Modern Platforms:** Overview of the Raspberry Pi 4 Board – Block Diagram and Components, Key Features, and a Brief Description.	

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand common terms used in microprocessor and microcontroller literature, and **describe** the architecture, features, memory organization, and I/O ports of the 8051 family of microcontrollers, as well as differentiate microprocessors from microcontrollers.	K2
CO2	Describe the assembler directives, instruction sets, addressing modes, and stack operations of the 8051 microcontroller, and **illustrate** their use in simple assembly language programs for data manipulation, arithmetic, and program control.	K2
CO3	Describe the interfacing of external memory with the 8051 microcontroller and explain the functioning of its on-chip peripherals including timers/counters, interrupts, and serial communication.	K2
CO4	Explain the principles of I/O interfacing with LEDs, switches, displays, and data converters using the 8051 microcontroller, and describe the fundamentals of advanced embedded architectures including ARM7 and Raspberry Pi 4 in comparison with the 8051.	K2

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

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	The 8051 Microcontroller and Embedded Systems: Using Assembly and C	Muhammad Ali Mazidi, Janice G. Mazidi, Rollin D. McKinlay	Pearson Education	2nd Edition or later
2	The 8051 Microcontroller: Architecture, Programming, and Applications	Kenneth J. Ayala	Cengage Learning	3rd Edition or later
3	ARM System Developer's Guide: Designing and Optimizing System Software	Andrew N. Sloss, Dominic Symes, Chris Wright	Morgan Kaufmann Publishers	1st Edition or later
4	Microprocessors and Microcontrollers	A. Nagoor Kani	Mc Graw Hill Education	2nd Edition or later

5	ARM System - on-chip Architecture	Steve Furber	Pearson Education	2nd Edition, 2001

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Microcontrollers: Architecture, Programming, Interfacing and System Design	Raj Kamal	Pearson Education	Latest Edition
2	The 8051 Microcontroller	I. Scott MacKenzie	Pearson Education	4th Edition or later
3	Microcontrollers: Theory and Applications	Ajay V. Deshmukh	McGraw Hill Education	Latest Edition
4	The 8051 Microcontroller Based Embedded Systems	Manish K Patel	McGraw Hill	2014

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc22_ee12/preview
2	https://onlinecourses.nptel.ac.in/noc22_ee12/preview
3	https://onlinecourses.nptel.ac.in/noc22_ee12/preview
4	https://onlinecourses.nptel.ac.in/noc22_ee12/preview https://onlinecourses.nptel.ac.in/noc25_cs29/preview

SEMESTER S5

DATABASE MANAGEMENT SYSTEMS

Course Code	24SJPBERT504	CIE Marks	60
Teaching Hours/Week (L: T:P: R)	3-0-0-1	ESE Marks	40
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Nil	Course Type	Theory

Course Objectives:

1. Gain a comprehensive understanding of database fundamentals, including the architecture, languages, and classification of database management systems (DBMS).
2. Develop skills in designing and implementing databases using the Entity-Relationship (ER) model and relational model, including translating ER diagrams into relational schema and performing normalization.
3. Acquire knowledge of database concepts such as transaction processing, concurrency control, recovery mechanisms, and the characteristics and types of NoSQL databases.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basics of Database - Introduction and applications of DBMS, Purpose of database, View of Data, Database Languages, Database architecture and Classification, Database users and Administrators. ER model - Entity Sets, Relationship Sets, Attributes, Constraints, Removing Redundant Attributes in Entity Sets, Entity-Relationship Diagrams. Introduction to Relational Model - Structure of Relational Databases, Database Schema, Keys, Schema Diagrams, Synthesizing ER diagram to relational schema. Relational Query Languages - Introduction to Relational Query Languages, Relational Algebra, Relational Algebra Problems.	11
2	Introduction to Structured Query Language (SQL) - Overview of the SQL Query Language, SQL Data Definition, Basic Structure of SQL Queries Extended SQL Operations- Basic SQL Operations, Set Operations, Null Values. Advanced SQL Queries- Aggregate Functions, Nested Subqueries, Views, SQL Problems. Constraints and Automated Actions in SQL- assertions, Triggers, Procedures.	11

3	Relational Database Design - Different anomalies in designing a database, the idea of normalization, Functional dependency. Functional Dependencies and their properties- Armstrong's Axioms (proofs not required), Closures and their computation, Equivalence of Functional Dependencies (FD), Minimal Cover (proofs not required). Basic Normal Forms - First Normal Form (1NF), Second Normal Form (2NF). Advanced Normal Forms -Third Normal Form (3NF), Boyce Codd Normal Form (BCNF).	**11**
4	Transaction Processing Concepts - overview of concurrency control, Transaction Model, Significance of concurrency Control & Recovery, Transaction States, System Log, Desirable Properties of transactions. Transaction Schedules and Serializability- Serial schedules, Concurrent and Serializable Schedules, Conflict equivalence and conflict serializability, Recoverable and cascade-less schedules. Concurrency Control and Recovery Techniques- Locking, Two-phase locking and its variations. Log-based recovery, check-pointing. NoSQL Databases - Introduction, properties of NoSQL Databases, types of No SQL Databases.	**11**

Course Assessment Method

(CIE: 60 marks, ESE: 40 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**30**	**12.5**	**12.5**	**60**

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 2 marks **(8x2 =16 marks)**	• Each question carries 6 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x6 = 24 marks)**	**40**

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Comprehend and exemplify the fundamental nature and characteristics of database systems, and model real-world scenarios using Entity-Relationship diagrams.	K3
CO2	Develop and execute efficient queries to create, manage, and retrieve data in relational databases.	K3
CO3	Demonstrate the features of Normalization in database applications.	K3
CO4	Discuss and compare the aspects of Concurrency Control and Recovery in Database systems.	K3
CO5	Explain various types of NoSQL databases.	K2

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

CO-PO Mapping Table:

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

Text Books

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Database Systems: Models, Languages, Design and Application Programming	Elmasri R. and S. Navathe	Pearson Education	6/e, 2013
2	Database System Concepts	Sliberschatz A., H. F. Korth and S. Sudarshan	McGraw Hil	6/e, 2011

Reference Books				
Sl. No.	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	NoSQL Data Models: Trends and Challenge	Olivier Pivert (Editor)	Wiley	2018
2	NoSQL for Dummies	Adam Fowler	John Wiley & Sons	2015

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106105175
2	https://www.coursera.org/learn/sql-data-science
3	https://www.udemy.com/course/database-normalization-simplified
4	https://archive.nptel.ac.in/courses/106/104/106104135/

SEMESTER 5

PROGRAM ELECTIVE – II

PROGRAM ELECTIVE 2: 24SJPEERT 52N

SLOT	COURSE CODE	COURSES	L-T-P-R	HOURS	CREDIT
E	24SJPEERT 521	Wireless Sensor Networks	3-0-0-0	3	3
	24SJPEERT 522	CMOS VLSI Design	3-0-0-0		3
	24SJPEERT 523	Sensors and actuators	3-0-0-0		3
	24SJPEERT 524	Cloud Computing	3-0-0-0		3
	24SJPEERT 526	Python for Machine Learning	3-0-0-0		3
	24SJPEERT 525	Computational Fundamentals for Machine Learning	3-0-0-0		5/3

SEMESTER S5

WIRELESS SENSOR NETWORKS

Course Code	24SJPEERT 521	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To understand the fundamentals of wireless sensor networks and its applications.
2. To study the various protocols at various layers.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction and Overview of Wireless Sensor Networks: Background of Sensor Network Technology – Application of Sensor Networks-Basic overview of the technology- Basic Sensor Network Architectural Elements- Survey of Sensor Networks - Applications of Sensor Networks: Introduction- Background-Range of Applications-Examples of Category 2 WSN Applications- Examples of Category 1 WSN Applications-Taxonomy of WSN Technology.	9
2	Basic Wireless Sensor Technology: Introduction-Sensor Node Technology- Sensor Taxonomy. WN Operating Environment- WN Trends -Wireless Transmission Technology and Systems: Radio Technology Primer- Propagation and Propagation Impairments – Available Wireless Technologies-Campus Applications- MAN/WAN Applications.	9
3	Medium Access Control Protocols for Wireless Sensor Networks: Introduction- Background Fundamentals of MAC Protocols-Performance Requirements-Common Protocols-MAC Protocols for WSNs-Sensor-MAC Case Study-IEEE 802.15.4 LR –WPANs Standard Case Study-PHY Layer- MAC Layer.	9

4	Routing Protocols for Wireless Sensor Networks: Data Dissemination and Gathering-Routing Challenges and Design Issues in Wireless Sensor Networks-Routing Strategies in Wireless Sensor Networks- Transport Control Protocols for Wireless Sensor Networks: Traditional Transport Control Protocols- Transport Protocol Design Issues- Examples of Existing Transport Control Protocols-Performance of Transport Control Protocols- Middleware for Wireless Sensor Networks: WSN Middleware Principles-Middleware Architecture-Existing Middleware.	**9**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the overview of wireless sensor networks and wireless sensor node architectures.	**K2**
CO2	Apply the concepts of basic wireless sensor technology to demonstrate its applications in real-world scenarios.	**K3**
CO3	Apply the fundamentals of MAC protocols to analyze and demonstrate their performance in wireless sensor networks.	**K3**
CO4	Describe the infrastructure, topology, routing, Challenges and Design Issues for wireless sensor networks.	**K2**

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

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

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

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

Text Books				
SL No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Wireless Sensor Networks: Technology, Protocols, and Applications	Kazem Sohraby, Daniel Minoli and Taieb Znati	John Wiley & Sons	2007

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Protocols and Architectures for Wireless Sensor Networks	Holger Karl and Andreas Willig	John Wiley & Sons	2007
2	Handbook of Sensor Networks:Compact Wireless and Wire Sensing System	Mohammad Ilyas and Imad MahGoub	CRC Press	2005

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106/105/106105160/
2	https://onlinecourses.swayam2.ac.in/arp19_ap52/preview
3	https://cse.iitkgp.ac.in/~smisra/course/wasn.html
4	https://youtu.be/ycaz99NogS4?si=TemMsONNFER22HeQ, https://youtu.be/PssAY3wgQqE?si=qRTYWduHXZRb4-6-

SEMESTER S5

CMOS VLSI DESIGN

Course Code	**24SJPEERT 522**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course objectives:

- To explain the operation and performance of advanced CMOS inverters and logic circuits
- To describe and analyze sequential MOS logic circuits and advanced logic families

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Advanced CMOS Inverter and Circuit Issues** Review of CMOS Inverter operation, Latch-up in CMOS circuits, Causes and Prevention techniques, Advanced inverter structures - Tristate inverter, Bi CMOS inverter. Performance parameters - Static, dynamic and short circuit power dissipations. Propagation delay, Power Delay Product	**9**
2	**Sequential MOS Logic Circuits** Introduction -Timing Metrics for sequential circuits, Latches and Registers-SR Latch, Clocked latch and flip flop circuits, Datapath Subsystems- Adder, Full adder, Carry Look Ahead Adder, Multiplier-Array Multiplier, Carry Save Multiplier, Shifter - Barrel Shifter.	**9**
3	**Advanced Static Logic Families** Limitations of basic CMOS logic, Static Logic Circuits -NMOS Logic, Pseudo-NMOS Logic, Ratioed logic, Pass Transistor Logic, Pass Transistor Logic (PTL) families: DPTL, CPTL. Differential Cascode Voltage Switch Logic (DCVS), Differential Split-Level Logic (DSL)	**9**
4	**High-Performance Dynamic Logic Circuits** Cascading issues in dynamic logic circuits, Clocked CMOS Logic (C^2MOS), Domino logic, N-P Domino (NORA) logic, operations, Zipper CMOS Dynamic Logic, True Single-Phase Clock (TSPC) logic - Multiple Output Domino Logic (MODL)	**9**

Course Assessment Method

(CIE: -40 Marks, ESE: 60 Marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Evaluation -1	Internal Evaluation-2	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

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

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

Course Outcomes (COs)

At the end of the course the student will be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe CMOS inverter operation, latch-up, and advanced inverter circuits.	K2
CO2	Explain sequential MOS circuits and basic datapath subsystems	K2
CO3	Compare different static logic families and their applications.	K2
CO4	Analyze dynamic logic circuits and their use in high-performance design.	K2

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

CO-PO Mapping Table:

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

Text Books				
SL No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	CMOS Digital Integrated Circuits- Analysis and Design	Sung- Mo- Kang, Yusuf Leblebici	TATA McGraw-Hill	3e, 2003
2	CMOS VLSI Design, a Circuits and Systems Perspective	Neil H. E. Weste, David Money Harris	PEARSON	4e, 2015

Reference Books				
SL No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Integrated Circuits- A Design Perspective	J.M. Rabaey, A. Chandrakasan and B. Nikolic	PHI	2e, 2016
2	CMOS Logic Circuit Design	John P. Uyemura	Springer India Pvt. Ltd	2005

Video Links (NPTEL, SWAYAM etc):	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc21_ee09/preview
2	https://onlinecourses.nptel.ac.in/noc21_ee09/preview
3	https://onlinecourses.nptel.ac.in/noc21_ee09/preview
4	https://onlinecourses.nptel.ac.in/noc21_ee09/preview

SEMESTER S5

SENSORS AND ACTUATORS

Course Code	24SJPEERT 523	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Basic Physics, Basic Circuit Theory	Course Type	Theory

Course Objectives:

The course is designed to enable students, to:

1. Understand the fundamental principles and terminology used in electronic measurement systems.
2. Explain the working and characteristics of major families of passive sensors (Resistive, Inductive, Capacitive).
3. Identify and select appropriate sensors and transducers for measuring specific physical quantities (Temperature, Pressure, Flow, etc.).
4. Differentiate between various types of actuators and their control methods for simple applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Measurement Systems and Terminology:** Basic measurement system (functional block diagram, input/output concept). Classification of sensors (active/passive, primary/secondary). Key Static Characteristics: Accuracy, Precision, Resolution, Sensitivity, Hysteresis, Span, Linearity. Errors in Measurement (Gross, Systematic, Random errors; sources of error). Introduction to Transduction: Define Transducer and Sensor.	9
2	**Fundamental Sensor Principles:** Basic concept of electrical change (Resistive, Inductive, Capacitive) as a function of physical quantity. Resistive Sensors: Working principle and detailed study of: Potentiometers (Linear/Rotary), Strain Gauges (Gauge factor - no derivation is needed; basic Wheatstone bridge concept for measurement), RTDs (Resistance Temperature Detectors), and Thermistors. Inductive Sensors: Principle of operation, LVDT (structure and application - no derivation is needed). Capacitive Sensors: Principle of operation, parallel plate types, application in displacement measurement. Magnetic Sensors: Hall Effect Sensor (principle and use).	9

3	**Application-Specific Transducers and Measurements:** Temperature Measurement: Thermocouples (Seebeck effect, basic reference junction - no derivation is needed). Pressure Measurement: Diaphragm/piezo-resistive type. Flow Measurement: Orifice Plate/Venturi Meter (Basic principle only - no derivation is needed), Turbine flowmeter (concept). Force/Torque Measurement: Load Cells (using strain gauges). Optical Sensors: Photoresistor (LDR), Photodiode, usage in counting/detection. pH Measurement (Electrode concept and conditioning need, basic block diagram).	**9**
4	**Actuators and Control Elements:** Definition and classification of Actuators. Electrical Actuators: Solenoids (working and application). Motors: DC Motor (working principle - no derivation is needed), Stepper Motor (open-loop control concept), Servo Motor (basic position control). Pneumatic/Hydraulic Actuators (brief overview of cylinder and valve principles). Relays and Solid-State Switches (use as interfacing elements).	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the functional blocks of a measurement system and define key sensor characteristics (Accuracy, Sensitivity, Hysteresis).	K2
CO2	Understand the working principle of fundamental sensor types: resistive, inductive, and capacitive, and recall their applications.	K2
CO3	Describe the basic operation of industrial transducers used for measuring specific physical quantities like temperature, pressure, and flow.	K2
CO4	Define the classification of actuators and understand the basic working principle of electrical (motors, solenoids) and fluid-based (hydraulic/pneumatic) actuators.	K2

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

CO-PO Mapping Table:

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

Text Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	A Course in Electrical and Electronic Measurements and Instrumentation	A. K. Sawhney, Puneet Sawhney	Dhanpat Rai & Co.	12th Revised Edition, 2014
2	Principles of Measurement and Instrumentation	Alan S. Morris, Reza Langari	Elsevier/Academic Press	4th Edition, 2015
3	Sensors and Actuators: Engineering System Instrumentation	Clarence W. de Silva	CRC Press/Routledge	2nd Edition, 2016
4	Process Control	K. Krishnaswamy	New Age International	2nd Edition, 2009
5	Hydraulics and Pneumatics	Andrew Parr	Elsevier Science	2nd Edition, 1999

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Handbook of Modern Sensors: Physics, Designs and Applications	Jacob Fraden	Springer	5th Edition, 2016
2	Sensors and Signal Conditioning	Ramón Pallás-Areny, John G. Webster	Wiley	3rd Edition, 2018
3	Electrical and Electronic Measurements and Instrumentation	R. K. Rajput	S. Chand & Company	Reprint/Updated Edition, 2021
4	Sensors and Actuators in Mechatronics, Design and Applications	Andrzej M. Pawlak	Taylor & Francis Group	1st Edition, 2007
5	Mechatronic systems, Sensors and Actuators Fundamentals and Modelling	Robert H. Bishop	Taylor & Francis Group	2nd Edition, 2007
6	Process Control Instrumentation Technology	Curtis D. Johnson	Pearson/Prentice Hall	8th Edition, 2014
7	Sensors and Transducers	D. Patranabis	PHI Learning	2nd Edition, 2004

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc21_ee32/preview
2	https://onlinecourses.nptel.ac.in/noc21_ee32/preview
3	https://onlinecourses.nptel.ac.in/noc21_ee32/preview
4	https://onlinecourses.nptel.ac.in/noc24_ee68/preview https://onlinecourses.nptel.ac.in/noc21_ee32/preview

SEMESTER S5

CLOUD COMPUTING

Course Code	24SJPEERT 524	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Understand Cloud Computing Fundamentals.
2. Explore Cloud Technologies and Platforms.
3. Apply Cloud Solutions and Ensure Security.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Computing** - Traditional computing- Limitations. Overview of Computing Paradigms-Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing. **Cloud Computing Fundamentals** - NIST reference Model-Basic terminology and concepts. Cloud characteristics, benefits and challenges, Roles and Boundaries. **Cloud service Delivery Models**-Infrastructure-as-a-Service (IaaS), Platform-as-a-Service(PaaS),Software-as-a-Service (SaaS), XaaS (Anything-as-a-service). **Cloud Deployment Models-** Public cloud, Community cloud, Private cloud, Hybrid cloud.	8
2	**Introduction to virtualization-**Virtualizing physical computing resources, Virtual Machines (Machine virtualization), non-virtualized v/s virtualized machine environments. **Types of Virtual Machines & Techniques-** Types of VMs- process VM v/s system VM, Emulation, interpretation and binary translation. Hardware-level virtualization- Hypervisors/VMM, Types of Hypervisors. **Virtualization Approaches-** Full Virtualization, Para- Virtualization, Hardware-assisted virtualization, OS level virtualization.	8

	Specialized Virtualization & Evaluation- Basics of Network Virtualization, Storage Virtualization and Desktop Virtualization, Pros and cons of virtualization.	
3	**Broadband networks and internet architecture-** Internet Service Providers (ISPs), Data center technology, Web technology, Multitenant technology, Service technology. Resource provisioning techniques-static and dynamic provisioning. **Open-source cloud platforms**-OpenStack, CloudStack, Basics of Eucalyptus, Open Nebula, Nimbus. **Cloud Programming Foundations-** Parallel Computing and Programming Paradigms, Map Reduce Model- Concepts and Applications **Cloud Programming Frameworks &Tools**- Hadoop Library from Apache, HDFS, Pig Latin High Level Languages, Apache Spark.	**8**
4	**Security Fundamentals-** Basic terms and concepts in security- Threat agents, Cloud security threats/risks, Trust. Operating system security-Virtual machine security- Security of virtualization- Security Risks Posed by Shared Images, Security Risks Posed by Management OS. **Infrastructure security-** Network Level Security, Host Level Security, Application level security, Security of the Physical Systems. **Identity and Access Management-** Identity and Access Management(IAM), Access Control. **Cloud Service Providers and Platforms**- Amazon Web Services(AWS):- AWS ecosystem- Computing services, Amazon machine images, Elastic Compute Cloud (EC2), Advanced compute services. Storage services-Simple Storage System(Amazon S3), Elastic Block Store (Amazon EBS). Google Cloud Platform:- IaaS Offerings: Compute Engine (GCE), Cloud Storage, PaaS Offerings: Google App Engine (GAE), Storage services, Application services, Compute services, Database Services, SaaS Offerings: Gmail, Docs, Google Drive. Microsoft Azure: Azure Platform Architecture, Hyper-V, Azure Virtual Machine, Compute services, Storage services	**12**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Explain the various cloud computing models and services.	K2
CO2	Demonstrate the significance of implementing virtualization techniques.	K2
CO3	Explain different cloud enabling technologies and compare private cloud platforms	K2
CO4	Explain appropriate cloud programming methods to solve big data problems	K2
CO5	Describe the need for security mechanisms in cloud and Compare the different popular cloud computing platforms	K2

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

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Cloud Computing Concepts, Technology &Architecture	Thomas, E., Zaigham M., Ricardo P	Prentice Hall	2013
2	Mastering cloud computing: foundations and applications programming	Buyya, R., Vecchiola, C., & Selvi, S. T.	Morgan Kaufmann	2017
3	Cloud computing	Bhowmik, S	Cambridge University Press	2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Cloud computing: theory and practice	Marinescu, D. C	MorganKaufmann	2017
2	Cloud computing: Principles and paradigms	Buyya, R., Broberg, J., & Goscinski, A. M	John Wiley & Sons.	2011

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	**https://archive.nptel.ac.in/courses/106/105/106105167/**
2	**https://onlinecourses.nptel.ac.in/noc23_cs90/preview**
3	**https://onlinecourses.nptel.ac.in/noc22_cs18/preview**
4	**https://archive.nptel.ac.in/courses/106/105/106105167/**

SEMESTER S5

COMPUTATIONAL FUNDAMENTALS FOR MACHINE LEARNING

Course Code	24SJPEERT 525	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. The purpose of this course is to introduce mathematical foundations of basic Machine Learning concepts among learners, on which Machine Learning systems are built.
2. This course helps the learners to understand the mathematical principles in Machine Learning and aid in the creation of new Machine Learning solutions, understand & debug existing ones, and learn about the inherent assumptions & limitations of the current methodologies.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	LINEAR ALGEBRA: Systems of Linear Equations – Matrices, Solving Systems of Linear Equations. Vector Spaces –Vector Spaces, Linear Independence, Basis and Rank. Linear Mappings – Matrix Representation of Linear Mappings, Basis Change, Image and Kernel. OPTIMIZATION: Optimization Using Gradient Descent - Gradient Descent with Momentum, Stochastic Gradient Descent. Constrained Optimization and Lagrange Multipliers - Convex Optimization - Linear Programming - Quadratic Programming.	12
2	ANALYTIC GEOMETRY, MATRIX DECOMPOSITIONS: Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Orthogonal Projections – Projection into One Dimensional Subspaces, Projection onto General Subspaces, Gram- Schmidt Orthogonalization. Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation.	8
3	VECTOR CALCULUS: Differentiation of Univariate Functions - Partial Differentiation and Gradients, Gradients of Vector Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients. Back	8

	propagation and Automatic Differentiation – Gradients in a Deep Network, Automatic Differentiation. Higher Order Derivatives, Linearization and Multivariate Taylor Series.	
4	Probability and Distributions: Construction of a Probability Space - Discrete and Continuous Probabilities, Sum Rule, Product Rule, and Bayes' Theorem. Summary Statistics and Independence – Gaussian Distribution - Conjugacy and the Exponential Family - Change of Variables/Inverse Transform.	**8**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

Assignment: 20 Marks

Students should evaluate and analyze a real-world problem, assess the proposed solutions, provide a conclusion on which solution is most appropriate for the problem.

Criteria for evaluation:

1. ***Problem Definition (K4 - 4 points)***
    a. *Clearly defines the real-world problem.*
    b. *Examine and identifies relevant contextual factors (constraints, resources, objectives).*
2. ***Problem Analysis (K4 - 4 points)***
    a. *Break-down and presents a well-reasoned solution approach.*
    b. *Compare and justify the proposed solutions with evidence and logical reasoning.*
3. ***Evaluate (K5 - 4 points)***
    a. *Thoroughly evaluate the proposed solutions.*
    b. *Compares trade-offs, advantages, and disadvantages.*

c. *Considers feasibility, scalability, and practical implications.*

4. ***Implementation (K5 - 4 points)***

   a. *Select the most feasible solution by implementing the proposed solutions.*

   b. *Successfully translates the chosen solution into code.*

   c. *Demonstrates proficiency in coding practices (readability, efficiency, error handling).*

5. ***Conclusion (K4- 2 points, K5 – 2 points)***

   a. *Summarizes findings and insights. State which solution is most appropriate for the problem.* ***(K4)***

   b. *Reflects critical thinking and informed decision-making.* ***(K5)***

Scoring:

1. ***Accomplished (4 points)****: Exceptional analysis, clear implementation, and depth of understanding.*
2. ***Competent (3 points)****: Solid performance with minor areas for improvement.*
3. ***Developing (2 points)****: Adequate effort but lacks depth or clarity.*
4. ***Minimal (1 point)****: Incomplete or significantly flawed.*

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Make use of the concepts, rules and results about linear equations, matrix algebra, vector spaces, eigenvalues & eigenvectors and orthogonality & diagonalization to solve computational problems.	K3
CO2	Perform calculus operations on functions of several variables and matrices, including partial derivatives and gradients.	K3
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.	K3
CO4	Train Machine Learning Models using unconstrained and constrained optimization methods.	K5

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

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Mathematics for Machine Learning	Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong	Cambridge University Press	2020

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Linear Algebraand Its Applications	Gilbert Strang	Cengage India Private Limited	4e/2014
2	Linear Algebra Done Right	Axler, Sheldon	Springer	2015
3	Introduction to Applied Linear Algebra	Stephen Boyd and Lieven Vandenberghe	Cambridge University Press	2018
4	Convex Optimization	Stephen Boyd and Lieven Vandenberghe	Cambridge University Press	2004
5	Pattern Recognition and Machine Learning	Christopher M Bishop	Springer	2009
6	Learning with Kernels – Support Vector Machines, Regularization, Optimization, and Beyond	Bernhard Scholkopf and Smola, Alexander J Smola	MIT Press	2002
7	Information Theory, Inference, and Learning Algorithms	David J. C MacKay	Cambridge University Press	2003
8	Machine Learning: A Probabilistic Perspective	Kevin P Murphy	MIT Press	2012
9	The Nature of Statistical Learning Theory	Vladimir N Vapnik	Springer	2000

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/106/106106139/

SEMESTER S5

PYTHON FOR MACHINE LEARNING

Course Code	24SJPEERT 526	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs 30 Mins
Prerequisites (if any)	24SJICEST105	Course Type	Theory

Course Objectives:

1. To provide foundational Python programming skills and data manipulation techniques.
2. Enabling learners to handle data, create visualizations, and apply basic machine learning algorithms using Python.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Programming Environment and Python Basics:** Python Programming - How python works? Using editors - IDLE, Jupyter. Working with data types, Strings, Keywords, Variables, Operators, Expressions. Data representation: Working with List, tuple, Sets, Dictionary. Control statements - Selection structure (if-else, switch-case), Iteration (for/while loop). Functions - Arguments and return values, Variable scopes and parameter passing, Recursion, Lambda functions.	9
2	**Object Oriented Programming:** Design with classes - Objects and Classes, Methods, Instance Variables, Constructor, Accessors and Mutators. Structuring classes with Inheritance and Polymorphism. Abstract Classes, Interfaces. Exceptions - Handle a single and multiple exceptions.	9
3	**Data Processing:** 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.	9
4	**Data Visualization and Analysis:**	9

	Plotting and visualization- Matplotlib and Seaborn (plots, histograms, boxplots, pairplots). Working with CSV files. Pandas - DataFrames, Series, Reading, Manipulating, and Processing Data. Case study on classification and Regression. Introduction to Micro service using Flask.	

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Write, test, and debug Python programs using basic constructs, control statements, functions, and core data structures	K3
CO2	Implement Object-Oriented Python programs and handle exceptions.	K3
CO3	Develop Python programs to process data using file handling and NumPy for efficient numerical computations.	K3
CO4	Apply Pandas for data analysis, visualize data.	K3

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fundamentals of Python: First Programs	Kenneth A Lambert	Cengage Publishing	2/e, 2016
2	Python for Data Analysis	Wes McKinney	Shroff / O'Reilly Publishers	2/e, 2017
3	Flask: Building Python web services	Jack Stouffer, Shalabh Aggarwal, Gareth Dwyer	PACKT Publishing Limited	2018

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Learn Python 3 The Hard Way	Zed A Shaw	Addison-Wesley	2017
2	Think Python: How to Think Like a Computer Scientist	Allen B. Downey	Schroff	2/e, 2016
3	Python Programming	Michael Urban and Joel Murach	Shroff/Murach	2016
4	Python Essential Reference	David M.Baezly	Addison-Wesley Professional	4/e, 2009
5	Introduction to Machine Learning with Python A Guide for Data Scientists	Andreas C. Müller & Sarah Guido	O'REILLY	2016
6	Python Data Science Handbook Essential Tools for Working with Data	Jake VanderPlas	O'REILLY	2016

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	Programming in Python https://onlinecourses.swayam2.ac.in/cec22_cs20/preview
2	Python for Data Science https://onlinecourses.nptel.ac.in/noc22_cs32/preview
3	Introduction to Machine Learning (IITKGP) https://onlinecourses.nptel.ac.in/noc19_cs52/preview

SEMESTER: S5

DIGITAL SIGNAL PROCESSING LABORATORY

Course Code	24SJPCERL 507	CIE Marks	50
Teaching Hours/Week (L:T:P:R)	0:0:3:0	ESE Marks (Internal only)	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	24SJPCERT 501 Digital Signal Processing 24SJGXEST 204 Programming in C	Course Type	Lab

Course Objectives:

1. Simulate DSP algorithms using MATLAB/PYTHON/OCTAVE/SCILAB
2. Perform real time DSP computing on development boards

Expt. No.	Experiments
	PART-A **Experiments based on MATLAB/PYTHON/SCILAB/OCTAVE** **(7 experiments are mandatory)**
1	Generation of Waveforms (Continuous and Discrete).
2	Time and Frequency Response of LTI systems (First and second order).
3	Linear Convolution, Circular Convolution and Linear Convolution using Circular Convolution.
4	To find the DFT and IDFT for the given input sequence.
5	Linear convolution using DFT.
6	To find FFT and IFFT for the given input sequence.
7	FIR and IIR filter design using Filter Design Toolbox.
8	FIR Filter (Low-pass, High-pass and Band-pass) design (Window method).
9	IIR Filter (Low-pass, High-pass) design (Butterworth).
	Part -B

	Experiments on Digital Signal Processor/ DSP kits (3 experiments are mandatory)
1.	Generation of sine wave and standard test signals.
2.	Convolution: Linear and Circular.
3.	Real time FFT of the signal using a real-time input signal.
4.	Real Time FIR Filter implementation (Low-pass, High-pass) using a real-time input Signal

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE):

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Simulate digital signals.	**K2**
CO2	Understand LTI systems and its properties	**K2**
CO3	Simulate efficient DFT algorithms and digital filters	**K2**
CO4	Familiarize the DSP hardware and interface with computer.	**K2**
CO5	Understand the spectrum of real time signals.	**K2**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Signal Processing, A Practical approach	Sanjit K. Mitra	Tata McGraw Hill Publishing Company Limited	2005
2	Digital signal processing using MATLAB.	Ingle, Vinay K., and John G. Proakis	Brooks/Cole Publishing Co.,	1999
3	Think DSP: digital signal processing in Python.	Downey, Allen	O'Reilly Media, Inc.	2016
Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Signal Processing Principles, Algorithms, Applications	John G Proakis, G. Manolakis,	Prentice Hall India Private Limited, Fourth Edition	2007
2	Discrete time Signal Processing	Allen V. Oppenheim, Ronald W. Schafer	Prentice Hall India Private Limited, Fifth Edition	200
3	DSP applications using C and the TMS320C6x DSK.	Chassaing, Rulph	John Wiley & Sons	2003

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc19_ee50/preview
2	https://onlinecourses.nptel.ac.in/noc21_ee20/preview
3	https://onlinecourses.nptel.ac.in/noc22_ee62/preview

Continuous Assessment (25 Marks)

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

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

2. **Conduct of Experiments (7 Marks)**

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

3. **Lab Reports and Record Keeping (6 Marks)**

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

4. **Viva Voce (5 Marks)**

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

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

Evaluation Pattern for End Semester Examination (50 Marks)

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

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

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

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

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

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

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

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

5. **Record (5 Marks)**

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

SEMESTER S5

DATABASE MANAGEMENT SYSTEMS LAB

Course Code	**24SJPCERL508**	**CIE Marks**	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	24SJPBERT504	**Course Type**	Lab

Course Objectives:

1. Enable students to design, create, and manage databases using practical tools.
2. Equip students with the skills to write and execute SQL queries for various database operations.
3. Introduce students to NoSQL databases and Big Data technologies like MongoDB for handling large datasets

Details of Experiment

Expt. No	Experiment
1	Design a database schema for an application with ER diagram from a problem description
2	Creation, modification, configuration, and deletion of databases using UI and SQL Commands
3	Creation of database schema - DDL (create tables, set constraints, enforce relationships, create indices, delete and modify tables)
4	Database initialization - Data insert, Data import to a database
5	Practice SQL commands for DML (insertion, updating, altering, deletion of data, and viewing/querying records based on condition in databases)
6	Implementation of built-in functions in RDBMS
7	Implementation of various aggregate functions in SQL
8	Implementation of Order By, Group By & Having clause
9	Implementation of set operators nested queries, and join queries
10	Practice of SQL TCL commands like Rollback, Commit, Save point
11	Practice of SQL DCL commands for granting and revoking user privileges
12	Practice of SQL commands for creation of views and assertions

13	Implementation of various control structures like IF-THEN, IF-THEN-ELSE, IF-THEN-ELSIF, CASE, WHILE using PL/SQL
14	Creation of Procedures, Triggers and Functions
15	Creation of Packages
16	Creation of Cursors
17	Familiarization of NoSQL Databases and CRUD operations
18	Design a database application using any front-end tool for any problem selected. The application constructed should have five or more tables

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE):

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

Mandatory requirements for ESE:

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

Course Outcomes (COs)

At the end of the course the student will be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Design database schema for a given real world problem-domain using standard design and modeling approaches.	**K3**
CO2	Construct queries using SQL for database creation, interaction, modification, and updation.	**K3**
CO3	Design and implement triggers and cursors.	**K3**
CO4	Implement procedures, functions, and control structures using PL/SQL.	**K3**
CO5	Perform CRUD operations in NoSQL Databases.	**K6**

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

CO-PO Mapping Table

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Database Systems: Models, Languages, Design and Application Programming	Elmasri R. and S. Navathe	Pearson Education	6/e, 2013
2	Database System Concepts	Sliberschatz A, H.F.Korth and Sudarshan	McGraw Hill	6/e, 2011

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	NoSQL Data Models: Trends and Challenge	Olivier Pivert (Editor)	Wiley	2018
2	NoSQL for Dummies	Adam Fowler	John Wiley & Sons	2015

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://nptel.ac.in/courses/106105175
2	https://www.coursera.org/learn/sql-data-science
3	https://www.udemy.com/course/database-normalization-simplified
4	https://archive.nptel.ac.in/courses/106/104/106104135/

Continuous Assessment (25 Marks)

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

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

2. Conduct of Experiments (7 Marks)

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

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.

- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

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

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

Evaluation Pattern for End Semester Examination (50 Marks)

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

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

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

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

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

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

4. Viva Voce (10 Marks)

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

5. Record (5 Marks)

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

SEMESTER 6

ELECTRONICS AND COMPUTER ENGINEERING

SEMESTER S6

OPERATING SYSTEMS

Course Code	**24SJPCERT601**	**CIE Marks**	**40**
Teaching Hours/Week (L: T:P: R)	3-1-0-0	**ESE Marks**	60
Credits	4	**Exam Hours**	2Hrs.30Min.
Prerequisites (if any)	24SJGXEST204	**Course Type**	Theory

Course Objectives:

1. Gain a comprehensive understanding of the basic functionalities, structure and components of modern operating systems.
2. Gain proficiency in tasks such as process creation, synchronization, and deadlock handling.
3. Understand the trade-offs involved in choosing between different scheduling algorithms, memory management strategies, and file system structures.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction:** Operating system overview – Operations, Functions, Service – System calls, Types – Operating System structure - Simple structure, Layered approach, Microkernel, Modules– System boot process. **Processes** - Process states, Process control block, threads, scheduling, Operations on processes - process creation and termination – Inter-process communication - shared memory systems,Message passing systems.	11
2	**Process Scheduling** – Basic concepts- Scheduling criteria -scheduling algorithms- First come First Served, Shortest Job First, Priority scheduling, Round robin scheduling. **Deadlocks:** Necessary conditions, Resource allocation graphs, Deadlock prevention, Deadlock avoidance – Banker's algorithms, Deadlock detection, Recovery from deadlock.	12
3	**Process synchronization**- Race conditions – Critical section problem – Peterson's solution, Synchronization hardware, Mutex Locks, Semaphores, Classic Synchronization problems - Producer Consumer, Dining Philosophers and Readers-Writers.	9

4	**Memory Management:** Concept of address spaces, Swapping, Contiguous memory allocation, fixed and variable partitions, Segmentation, Paging. Virtual memory, Demand paging, Page replacement algorithms. **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.	**12**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the relevance, structure and functions of Operating Systems in computingdevices along with the concepts of process management mechanisms employed in Operating Systems.	**K2**
CO2	Illustrate the mechanisms for process scheduling and deadlock handling.	**K3**
CO3	Explain the tools and mechanisms for process synchronization in Operating Systems.	**K2**
CO4	Elaborate on memory management and storage management techniques in Operating Systems.	**K3**

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

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Operating System Concepts	Abraham Silberschatz, Peter Baer Galvin, Greg Gagne,	Wiley India	9th Edition, 2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Modern Operating Systems	Andrew S Tanenbaum,	Prentice Hall	4th Edition, 2015
2	Operating systems	William Stallings,	Pearson, Global Edition	6th Edition, 2015.
3	Operating Systems	Garry Nutt, Nabendu Chaki, Sarmistha Neogy,	Pearson Education.	3rd Edition
4	Operating Systems	D.M.Dhamdhere,	Tata McGraw Hill	2nd Edition, 2011.
5	Operating Systems	Sibsankar Haldar, Alex A Aravind,	Pearson Education	2010

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://youtube.com/playlist?list=PL-8LShlBMIjWDrcc3I86VyGgMJyvcX7Ud&si=tWIli_IYZA3RqzPG
2	https://youtube.com/playlist?list=PL-8LShlBMIjWDrcc3I86VyGgMJyvcX7Ud&si=tWIli_IYZA3RqzPG
3	https://youtube.com/playlist?list=PL-8LShlBMIjWDrcc3I86VyGgMJyvcX7Ud&si=tWIli_IYZA3RqzPG
4	https://youtube.com/playlist?list=PL-8LShlBMIjWDrcc3I86VyGgMJyvcX7Ud&si=tWIli_IYZA3RqzPG

SEMESTER S6

DATA COMMUNICATION AND NETWORKING

Course Code	24SJPCERT602	**CIE Marks**	**40**
Teaching Hours/Week (L: T:P: R)	3-0-0-0	**ESE Marks**	**60**
Credits	3	**Exam Hours**	**2Hrs.30Min.**
Prerequisites (if any)	24SJPCERT403	**Course Type**	**Theory**

Course Objectives:

1. To analyze data transmission methods, error control mechanisms, and congestion management techniques in networking.
2. To understand the fundamental principles of data communication and networking protocols, including OSI and TCP/IP architectures.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Data communication and data networking- A data communication model, data communication, networks. Protocol architecture - the need for protocol architecture, TCP/IP protocol architecture, OSI Model. Data transmission - Concepts and terminology - Analog and Digital data transmission- Transmission Impairments – channel capacity	**8**
2	Digital data, Digital signals & Analog signals – Analog data, Digital signals & Analog signals. Asynchronous and synchronous transmission -Types of Error - Error Detection -Error Correction. Data link Control -Flow control-Error Control-HDLC.	**8**
3	Multiplexing-Frequency Division Multiplexing (FDM) – Synchronous Time Division Multiplexing (TDM) – statistical TDM – Asymmetric Digital Subscriber Line (DSL) – xDSL. Circuit Switching and packet switching: switched communication networks - circuit switching networks - circuit switching concepts - soft switch architecture-Packet switching principles-X.25-Frame Relay. Routing in Switched Networks: routing in circuit switched network – routing in packet switched network – least cost algorithms.	**10**

4	Effect of congestion - Congestion control - Traffic management - Congestion control in packet switching networks - Frame Relay congestion control. Local Area Network: LAN protocol architecture – bridges – layer2 and layer3 switches. High speed LANs: the emergence of High speed LAN's – Ethernet – token ring – fibre channel. Transport protocol: connection-oriented transport protocol mechanisms - TCP – TCP – congestion control - UDP.	**10**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
10	**10**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand data communication and networking using the layered concept, Open System Interconnect (OSI) and the TCP/IP Model.	**K2**
CO2	Illustrate various types of encoding techniques and error detection methods used in networks.	**K2**
CO3	Use the concept of multiplexing, switching and routing in networks.	**K3**
CO4	Discuss the working principles of LAN and the concepts behind congestion in networks.	**K2**

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

CO-PO Mapping Table:

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

Text Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Data and Computer Communication	William Stallings	Pearson Education	9/e,2013
2	Computer Networks	Andrew S. Tanenbaum	PHI (Prentice Hall India)	5/e,2013

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Data Communication and Networking	Behrouz A Forouzan	Tata McGraw Hill	5/e,2013
2	Computer Networks – A Systems Approach	Larry L Peterson and Bruce S Dave	Morgan Kaufmann.	5/e,2011
3	Computer Networking and the Internet	Fred Halsall	Addison-Wesley.	5/e,2005

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106105183
2	https://nptel.ac.in/courses/106105082
3	https://nptel.ac.in/courses/117105148
4	https://onlinecourses.nptel.ac.in/noc22_ee61/preview

SEMESTER 6

PROGRAM ELECTIVE - III

SEMESTER S6

NETWORK AND LINEAR CONTROL SYSTEMS

Course Code	24SJPEERT631	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. This course aims to develop the skills for mathematical modelling and analysis of linear control systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Electrical Circuits** Circuit concept – Types of elements - source transformation-voltage - current relationship for passive elements. Network reduction techniques: series, parallel, series parallel, examples, time and frequency domain analysis of RLC circuits. **Introduction to control systems** Basic components of a control system, types of control systems, examples of control systems, effect of feedback systems, Laplace Transforms, transfer function, modelling of electrical networks, block diagram reduction, signal flow graphs.	10
2	**Modelling of mechanical systems** Translational and rotational systems, transfer function for typical mechanical systems, analogous systems–force voltage & force-current analogy, impulse response and its relation with transfer function	8

3	**Time domain analysis of feedback control systems** Transient and steady-state response, standard test signals, type and order of systems, concept of poles and zeros, time response of first and second order systems to unit impulse and step input, time domain specifications, Steady-state response, steady state error, static and dynamic error coefficients.	9
4	**Stability of linear control systems** Concept of stability, methods of determining stability, Routh's Hurwitz criterion, Root locus - construction of root locus, effect of addition of poles and zeros on root locus. Frequency response analysis: Frequency domain specifications, stability from Bode plots, relative stability, gain margin and phase margin, introduction to lead, lag and lead-lag compensating networks (excluding design).	9

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Analysis and modelling of mechanical systems using translational and rotational systems, along with the understanding of force voltage & force-current analogy.	**K3**
CO2	Implementing techniques to ensure the stability of linear control systems; using the Routh's Hurwitz criterion, Root locus method and frequency response analysis.	**K3**
CO3	Understand and model control systems using Laplace Transforms and transfer functions to analyze electrical networks and control systems structures.	**K3**
CO4	Apply poles and zeros concept, analyze first and second order systems, and compute static and dynamic error coefficients within time domain analysis of feedback control systems.	**K3**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Network Analysis and Synthesis	Ravish R. Singh	McGraw Hill Education	2/e, 2019
2	Automatic Control Systems	Farid Golnaraghi, Benjamin C. Kuo	Wiley India	9/e, 2014

3	Control Systems	M. Gopal	McGraw Hill Education India	4/e, 2012

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Control System Engineering	Norman S. Nise	Wiley India	5/e, 2015
2	Modern Control Systems	Richard C Dorf and Robert H. Bishop	Pearson Education	13/e, 2016

Video Links (NPTEL, SWAYAM…)

Module No.	Link ID
1	https://archive.nptel.ac.in/courses/108/104/108104139/
2	https://nptel.ac.in/courses/107106081
3	https://nptel.ac.in/courses/107106081
4	https://nptel.ac.in/courses/107106081

SEMESTER S6

COURSE NAME: MICRO-ELECTRO-MECHANICAL SYSTEMS

Course Code	**24SJPEERT 632**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Mins.
Prerequisites (if any)	Nil	**Course Type**	Theory

Course Objectives:

1. Acquire a thorough understanding of MEMS products, microfabrication evolution, and multidisciplinary applications including micro sensors and actuators.
2. Gain proficiency in MEMS material selection, fabrication techniques, and microsystem packaging design considerations.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	MEMS and Microsystems: Typical MEMS and microsystem products – Evolution of Microfabrication - Microsystem and microelectronics - Multidisciplinary nature of MEMS – Applications of Microsystems in Automotive Industry - Principles and examples of Micro sensors and micro actuators – micro accelerometer, Micro grippers, micro motors, micro valves, micro pumps.	**9**
2	Actuation and Sensing techniques: Actuation using Thermal forces, Actuation using Shape Memory Alloys, Actuation using Piezoelectric crystals, actuation using Electrostatic forces; Microsensors - Acoustic wave sensors, Biomedical sensors and biosensors, chemical sensors, pressure sensors, optical sensors, thermal sensors - microfluidics.	**9**
3	Engineering science for Microsystem design - Atomic structure of Matter - Ions & ionization - Molecular Theory of matter & Intermolecular forces - Doping of semiconductors - Diffusion process - Electrochemistry - Quantum physics. Materials for MEMS and Microsystems - Substrate and wafer - Silicon as substrate Material - Silicon compounds - Silicon peizoresistors - Gallium Arsenide - Quartz - Peizoelectric crystals - Polymers.	**9**

4	Overview of Microsystem fabrication – Photolithography – Ion implantation-Diffusion – Oxidation – Chemical vapour deposition – Etching. Overview of Micro manufacturing – Bulk micro manufacturing, Surface micro machining, LIGA process. Micro system Packaging: general considerations in packaging design – Levels of Micro system packaging.	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic concepts of MEMS and microsystem products.	K2
CO2	Understand the working principles of micro sensors and actuators.	K2
CO3	Identify the typical materials used for fabrication of micro systems.	K2
CO4	Illustrate the various methods in microsystem fabrication and micro manufacturing.	K2

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

CO-PO Mapping Table:

	PO31	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	-	-	-	-	-	-	-	3
CO2	3	2	-	-	-	-	-	-	-	-	3
CO3	3	2	1	-	-	-	-	-	-	-	3
CO4	3	2	1	-	-	-	-	-	-	-	3

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	MEMS and Microsystems Design, Manufacture and Nanoscale Engineering	Tai-Ran Hsu,	Wiley	2nd, 2020
2	Foundations of MEMS	Chang Liu	Pearson	2nd, 2012
3	Microsystem Design	Stephen D Senturia	Springer	3rd, 2013

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Silicon VLSI Technology	James D Plummer	Prentice Hall	4th, 2012
2	MEMS	Nitaigur Premchand Mahalik	Tata Mc Graw Hill	2013
3	Micro and Nano Fabrication: Tools and Processes	Hans H. Gatzen	Springer	2015

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	NPTEL course : "MEMS & Microsystems" by Prof. Santiram Kal, Video Lecture No: 5, MEMS materials https://archive.nptel.ac.in/courses/117/105/117105082/
2	NPTEL course : "MEMS & Microsystems" by Prof. Santiram Kal, Video Lecture No: 13, Surface & Quartz Micromachining. https://archive.nptel.ac.in/courses/117/105/117105082/

SEMESTER S6

COURSE NAME: FOUNDATIONS OF DATA SCIENCE

Course Code	**24SJPEERT 633**	**CIE Marks**	**40**
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To understand the data science fundamentals and process.
2. To learn to describe the data for the data science process.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Data Science: Facets of data – structured, unstructured- semi structured data & patterns, Importance of data Science - History of Data Science -Need for Data Science, Steps in Data Science Process, Components of Data Science, Tools and skills needed - Differences between AI, ML, DL. Data Science & Data Analytics, Real world applications of data science- Simple case study based on real life applications such as - Market research case, tracking disease outbreaks, business predictions, (for example, Rating a product design).	**9**
2	Data Preprocessing: Need to preprocess the data- Major Tasks in Data Preprocessing, Data cleaning - Missing Values, Noisy Data, Data Cleaning as a Process, Data Integration- Entity identification problem, Redundancy and Correlation Analysis, Data Reduction- Data Reduction Strategies, Principal Components Analysis, Data Transformation and Data Discretization- Data Transformation Strategies, Data Transformation by Normalization, Discretization by binning.	**9**
3	Classification Models: Classification - Basic Concepts, K-Nearest- Neighbour Classifiers, Decision Tree Induction (ID3 algorithm), Naïve Bayesian Classification, Support Vector Machines	**8**

4	Mining Frequent Patterns, Associations, and Correlations: Basic Concepts Frequent Itemset - Apriori Algorithm - Generating Association Rules from Frequent Item sets Clustering: Partitioning methods- k-Means clustering, Hierarchical Methods- Agglomerative versus Divisive Hierarchical Clustering- Distance Measures in Algorithmic Methods, Density-Based Methods -DBSCAN	**10**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic principles and concepts of data science	K2
CO2	Pre-process and explore datasets to extract meaningful insights.	K3
CO3	Illustrate the concepts of classification methods	K3
CO4	Perform association mining and analyze clusters using different methods	K3

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

CO-PO Mapping Table:

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

Text Books

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Data Science	Sanjeev J. Wagh, Manisha S. Bhende, and Anuradha D. Thakare	CRC press	1e, 2022
2	Data mining Concepts and Techniques	Jiawei Han, Michelin Kamber, Jian Pei	Morgan Kaufmann Publishers	3e, 2012

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Data Mining Techniques	Arun K. Pujari	Universities Press	2001
2	Data Science for Business	Foster Provost, Tom Fawcett	O'Reilly Media	1e, 2013

Video Links (NPTEL, SWAYAM…)

Module No.	Link ID
1	https://archive.nptel.ac.in/courses/106/106/106106179/ https://www.youtube.com/watch?v=XohgKT13FKY
2	https://archive.nptel.ac.in/courses/106/105/106105174/
3	https://archive.nptel.ac.in/courses/106/105/106105174/ https://www.youtube.com/playlist?list=PLw5h0DiJ-9PCn4shW4X43FSjEqdBwc1Cn
4	https://archive.nptel.ac.in/courses/106/105/106105174/

SEMESTER 6

COMPILER DESIGN

Course Code	**24SJPEERT 634**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	24SJPCERT502	**Course Type**	Theory

Course Objectives:

1. To understand the structure and functionality of compilers, including lexical and syntax analysis, parsing techniques, and code optimization strategies.
2. To learn about implementing various phases of a compiler, from lexical analysis to code generation.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Analysis of the source program - Analysis and synthesis phases, Phases of a compiler. Lexical Analysis - Role of Lexical Analyzer, Input Buffering, Specification of Tokens, Recognition of Tokens.	9
2	Role of the Syntax Analyser. Review of Context Free Grammars - Derivation and Parse Trees. Basic parsing approaches - Eliminating left recursion, left factoring. Top-Down Parsing - Recursive Descent parsing, Predictive Parsing, LL(1) Grammars.	9
3	Handle Pruning. Shift Reduce parsing. LR parsing - Constructing SLR, LALR and canonical LR parsing tables. Syntax directed translation - Syntax directed definitions, S-attributed definitions, L-attributed definitions, Storage organization, Storage-allocation strategies.	9
4	Intermediate code generation- Intermediate languages, Graphical representations, Three-Address code, Quadruples, Triples. Code Optimization - Principal sources of optimization, Local and global optimizations. Code generation - Issues in the design of a code generator, Target Language, A simple code generator.	9

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Describe the phases in the compilation process (lexical analysis, syntax analysis, semantic analysis, intermediate code generation, code optimization, and code generation) and model a lexical analyzer.	**K3**
CO2	Describe the role of the syntax analyzer, review context-free grammars, and apply basic parsing approaches including top-down parsing techniques and LL (1) grammars.	**K3**
CO3	Illustrate handle pruning, shift-reduce parsing, LR parsing with SLR, LALR, and canonical LR tables, and apply syntax-directed translation concepts.	**K3**
CO4	Demonstrate intermediate code generation techniques, including intermediate languages and three-address code, as well as discuss code optimization strategies and the issues involved in code generation and design.	**K3**

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

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Compilers – Principles Techniques and Tools	Aho A.V., Ravi Sethi and D. Ullman.	Addison Wesley	2006

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	System Programming and Operating Systems	D. M. Dhamdhere	Tata McGraw Hill & Company	1996
2	Compiler Construction – Principles and Practice	Kenneth C. Louden	Cengage Learning Indian Edition	2006
3	The Theory and Practice of Compiler Writing	Tremblay and Sorenson	Tata McGraw Hill & Company	1984

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/105/106105190/
2	https://archive.nptel.ac.in/courses/106/105/106105190/
3	https://archive.nptel.ac.in/courses/106/105/106105190/
4	https://archive.nptel.ac.in/courses/106/105/106105190/

SEMESTER S6

COURSE NAME: DESIGN AND ANALYSIS OF ALGORITHMS

Course Code	**24SJPEERT 635**	**CIE Marks**	**40**
Teaching Hours/Week (L: T:P: R)	3-0-0-0	**ESE Marks**	60
Credits	5/3	**Exam Hours**	2Hrs.30Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. Develop a clear understanding of Algorithm Analysis, including Time and Space Complexity.
2. Develop the ability to apply various Algorithm Design Strategies through illustrative examples.
3. Acquire foundational knowledge of Complexity Theory and its significance in algorithm performance.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Algorithm - Analysis Time and Space Complexity Elementary operations and Computation of Time Complexity Best, worst and Average Case Complexities- Complexity Calculation of simple algorithms. Recurrence Equations - Solution of Recurrence Equations – Iteration Method and Recursion Tree Methods.	6
2	Master's Theorem (Proof not required) – examples, Asymptotic Notations and their properties- Application of Asymptotic Notations in Algorithm Analysis- Common Complexity Functions. AVL Trees – rotations, Red-Black Trees insertion and deletion (Techniques only; algorithms not expected). B-Trees – insertion and deletion operations. Sets- Union and find operations on disjoint sets.	8
3	Graphs – DFS and BFS traversals, complexity, Spanning trees – Minimum Cost Spanning Trees, single source shortest path algorithms, Topological sorting, strongly connected components. Divide and Conquer - The Control Abstraction, 2-way Merge sort, Strassen's Matrix Multiplication, Analysis. Dynamic Programming - The control Abstraction- The Optimality Principle- Optimal matrix multiplication, Bellman-Ford Algorithm.	10

	Analysis, Comparison of Divide and Conquer and Dynamic Programming strategies.	
4	Greedy Strategy - The Control Abstraction- the Fractional Knapsack Problem, Minimal Cost Spanning Tree Computation- Prim's Algorithm – Kruskal's Algorithm Back Tracking -The Control Abstraction – The N Queen's Problem, 0/1 Knapsack Problem. Branch and Bound: Travelling Salesman Problem. Introduction to Complexity Theory - Tractable and Intractable Problems- The P and NP Classes- Polynomial Time Reductions - The NP- Hard and NP-Complete Classes.	**12**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Analyze algorithms to determine their time and space complexities using asymptotic notations	**K4**
CO2	Solve recurrence relations using Iteration, Recurrence Tree, Substitution, or Master's Method to compute algorithmic time complexity.	**K3**
CO3	Analyze the functionality and applications of various graph traversal algorithms and advanced data structures in terms of structure and performance.	**K4**
CO4	Apply Divide-and-Conquer, Greedy, Dynamic Programming, Branch-and-Bound, and Backtracking techniques to design efficient algorithms.	**K3**
CO5	Classify computational problems as tractable or intractable and explain strategies for handling intractability.	**K2**

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

CO-PO Mapping Table:

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

Text Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computer Algorithms	Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran	Universities Press	2007
2	Introduction to Algorithms	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein	MIT Press	2009

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	The Design and Analysis of Computer Algorithms	Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman	Pearson Education	1999
2	Introduction to the Design and Analysis of Algorithms	Anany Levitin	Pearson	3/e, 2011
3	Fundamentals of Algorithmics	Gilles Brassard, Paul Bratley	Pearson Education	1995
4	Foundations of Algorithms using C++ Psuedocode	Richard E. Neapolitan, Kumarss Naimipour	Jones and Bartlett Publishers, Inc	2/e, 1997

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/106/106106131/
2	https://onlinecourses.nptel.ac.in/noc19_cs47/preview
3	https://onlinecourses.nptel.ac.in/noc19_cs47/preview
4	https://nptel.ac.in/courses/106101060

SEMESTER 6

ALGORITHM ANALYSIS & DESIGN

Course Code	**24SJPEERT 636**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	24SJPCERT 302	**Course Type**	Theory

Course Objectives:

1. To introduce the concepts of Algorithm Analysis, Time Complexity, Space Complexity.
2. To discuss various Algorithm Design Strategies with proper illustrative examples.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	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. Analysis of Recursive Algorithms: Recurrence Equations, Solving Recurrence Equations – Iteration Method, Recursion Tree Method, Substitution method and Master's Theorem (Proof not required).	9
2	Self-Balancing Tree - AVL Trees (Insertion and deletion operations with all rotations in detail, algorithms not expected), 2-3 Trees (Searching, insertion with node splitting and key promotion, properties of height-balance; algorithms not expected); DFS and BFS traversals - Analysis, Strongly Connected Components of a Directed graph, Topological Sorting.	9
3	The 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.	9

4	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. Introduction to Complexity Theory - Tractable and Intractable Problems, Complexity Classes – P, NP, NP- Hard and NP-Complete Classes	**9**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Evaluate the efficiency of algorithms using asymptotic notations, solve recurrence relations for recursive algorithms, and apply these concepts to optimize algorithmic solutions.	**K3**
CO2	Implement self-balancing AVL trees and 2-3 trees, perform DFS and BFS traversals, analyze strongly connected components of directed graphs, and apply topological sorting.	**K3**
CO3	Implement divide and conquer algorithms, apply greedy strategies, and evaluate shortest path solutions.	**K3**
CO4	Apply dynamic programming, backtracking, and branch and bound techniques, and understand complexity theory concepts.	**K3**

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

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer Algorithms	Ellis Horowitz, SartajSahni, Sanguthevar Rajasekaran	Universities Press	2007
2	Introduction to Algorithms	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein	MIT Press	2009

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	The Design and Analysis of Computer Algorithms	Alfred V. Aho, John E. Hopcroft and Jeffrey D.Ullman	Pearson Education	1999
2	Introduction to the Design and Analysis of Algorithms	Anany Levitin,	Pearson	3/e, 2011
3	Fundamentals ofAlgorithmics	Gilles Brassard, Paul Bratley	Pearson Education	1995

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/106/106106131/
2	https://archive.nptel.ac.in/courses/106/106/106106131/
3	https://archive.nptel.ac.in/courses/106/106/106106131/
4	https://archive.nptel.ac.in/courses/106/106/106106131/

SEMESTER S6

EMBEDDED SYSTEMS AND IOT

Course Code	**24SJPBERT 604**	**CIE Marks**	60
Teaching Hours/Week (L: T:P: R)	3:0:0:1	**ESE Marks**	40
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To give students a thorough understanding of designing embedded and internet of things systems for a range of applications
2. Expertise in the design and analysis of IOT and embedded systems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Embedded Systems and IoT** Introduction to Embedded Systems: - Desirable features and general characteristics of Embedded Systems -Comparison: Microcontroller Vs Microprocessors - Model of Embedded Systems. Introduction to IoT: - Evolution and enabling technologies of IoT - Complex Interdependence of Technologies - IoT Networking Components and Addressing Strategies. Basics of Networking: - Network Types and Layered Network Models - Addressing and TCP/IP Transport Layer. **Project Task**: Create a basic embedded system using a microcontroller, establish simple networking, and demonstrate data transfer over the network.	**11**
2	**Embedded Systems & IoT - Sensors, Actuators, and Processing** Sensors: -Sensor Characteristics, Sensorial Deviations, and Sensing Types - Sensing Considerations. Actuators: - Actuator Types and Characteristics. IoT Processing: - IoT Processing Topologies and Types -	**11**

	Data Format and Importance of Processing in IoT - Device Design and Selection Considerations - Processing Offloading. **Project Task:** Develop an IoT device integrating sensors and actuators with processing capabilities.	
3	**IoT Connectivity and Communication Technologies** IoT Connectivity Technologies: - Overview of IEEE 802.15.4, Zigbee, ISA100.11A, Wireless HART, RFID, NFC, Z-Wave, Weightless, LoRa, NB-IoT, Wi-Fi, Bluetooth. IoT Communication Technologies: - Infrastructure Protocols - Discovery Protocols - Data Protocols - Identification Protocols - Device Management - Semantic Protocols. **Project Task:** Implement connectivity and communication protocols for an IoT device.	**11**
4	**Developing IoT Applications with Arduino/NodeMCU** Arduino Platform: - Hardware features and Arduino IDE - Interfacing LEDs, switches, and LCDs. NodeMCU Platform: - Hardware features and programming with Arduino IDE - Interfacing sensors and actuators with NodeMCU. Introduction to Raspberry Pi - Raspberry Pi hardware details - installing OS in Raspberry Pi. IoT Physical Servers and Cloud Offerings: - Overview of AWS IoT, Microsoft Azure IoT, and Blynk. **Project Task:** Build comprehensive IoT applications using various platforms.	**11**

Each module includes a project-based activity. Students are required to complete and submit one project task, selected from any of the modules, within the course duration.

Course Assessment Method

(CIE: 60 marks, ESE: 40 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 2 marks **(8x2 =16 marks)**	• 2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 6 marks. **(4x6 = 24 marks)**	**40**

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basics of embedded systems, IoT and networking.	**K2**
CO2	Apply the concepts of sensors, actuators, and IoT processing to design and develop an IoT-enabled embedded system.	**K3**
CO3	Apply the understanding of IoT requirements and constrains to select the suitable IoT connectivity and communication technologies for specific IoT applications.	**K3**
CO4	Design an IoT applications integrated with physical servers and loud services.	**K3**

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

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to IoT	Sudip Misra, Anandarup Mukherjee, Arijit Roy	Cambridge University Press	First edition, 2021
3	Internet of Things With Raspberry Pi and Arduino	Rajesh Singh, Anita Gehlot, Lovi Raj Gupta, Bhupendra Singh, and Mahendra Swain	CRC press	1st Edition, 2019
4	NodeMCU ESP8266 Communication Methods and Protocols _ Programming with Arduino IDE	Manoj R. Thakur	Amazon Media E S.à r.l.	2018

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Internet of Things_ A Hands-On approach	Arshdeep Bahga, Vijay Madisetti	Universities Press	2015
2	Arduino Cookbook: Recipes to Begin, Expand, and Enhance Your Projects	Michael Margolis	O'Reilly Media	3rd edition, 2020
2	https://docs.aws.amazon.com/whitepapers/latest/aws- overview/introduction.html			
3	https://azure.microsoft.com/en-us/explore			
4	https://docs.blynk.io/en/			

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/128108016
2	https://nptel.ac.in/courses/128108016
3	https://nptel.ac.in/courses/128108016
4	https://nptel.ac.in/courses/128108016

SEMESTER S6

DESIGN THINKING AND PRODUCT DEVELOPMENT

Course Code	**24SJGBEST605**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	2:0:0:0	**ESE Marks**	60
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

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

SYLLABUS

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

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

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

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignments	Internal Examination	Reflective Journal and Portfolio	Total
5	**20**	**10**	**5**	**40**

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Empathize to capture the user needs and define the objectives with due consideration of various aspects including inclusivity, diversity and equity	**K5**
CO2	Ideate using divergent and convergent thinking to arrive at innovative ideas keeping in mind the sustainability, inclusivity, diversity and equity aspects.	**K6**
CO3	Engage in Human Centric Design of innovative products meeting the specifications	**K5**
CO4	Develop Proof of Concepts (PoC), prototypes & pilot build of products and test their performance with respect to the Specification Requirement Document.	**K4**
CO5	Reflect on professional and personal growth through the learnings in the course, identifying areas for further development	**K4**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Product Sense: Engineering your ideas into reality	Dr. K R Suresh Nair	NotionPress.com	2024
2	Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation	Tim Brown	HarperCollins Publishers Ltd.	2009
3	Design Thinking for Strategic Innovation	Idris Mootee	John Wiley & Sons Inc.	2013

Sample Assignments:

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

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

SEMESTER S6

EMBEDDED SYSTEMS AND IoT LAB

Course Code	**24SJPCERL 607**	**CIE Marks**	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	24SJPBERT 604	**Course Type**	Lab

Course Objectives:

1. To provide students a lot of hands-on experience designing different embedded systems and exposing them to the tools needed to make them Internet of Things devices.

Details of Experiment

Expt. No	Experiment
	Part A: Arduino based embedded system
1	Implement an arduino based system to detect when something is moved, tilted, or shaken.
2	Implement temperature control system by controlling a fan, if the temperature exceeds a limit. (Use arduino as control board)
3	Use Arduino to read the key presses on matrix keypad and display the pressed key on an LCD display.
4	Use Arduino to monitor one or more voltages and take some action when the voltage rises or falls below a threshold. For example, you want to flash an LED to indicate a low battery level—perhaps to start flashing when the voltage drops below a warning threshold and increasing in urgency as the voltage drops further.
5	Use Arduino to measure voltages greater than 5 volts. For example, you want to display the voltage of a 9V battery and trigger an alarm LED when the voltage falls below a certain level.
	Part B: NodeMCU based systems
6	Installing the Arduino IDE for the ESP8266 and connecting the module to your Wi-Fi network.
7	Reading data from a digital sensor connected to a digital pin of ESP8266.

8	Configuring the ESP8266 module and controlling an LED connected to it, from anywhere in the world; using MQTT.
9	Controlling the lock from the cloud using Blynk and NodeMCU.
10	Sending an e-mail/SMS notification based on activity at sensor connected to NodeMCU; using IFTTT.
Part C: Raspberry Pi based systems	
11	Setting up Raspberry Pi by installing OS and obtaining static IP of Raspberry Pi.
12	Light an LED by reading status of a switch connected to GPIO of the board.
13	Install Arduino IDE on Raspberry Pi and control LED using LDR; in which both are connected to Digital IO pin of Arduino.
14	Realize a datalogger with ThingSpeak Server: capture the real-time data of any sensor by Raspberry Pi and upload to the cloud.
15	Implement a Home Appliance Control system using Raspberry Pi using Blynk App

**** Any four experiments from Part1& Part2 and 3 experiments from Part3 are mandatory.**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE):

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

Mandatory requirements for ESE:

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

Course Outcomes (COs)

At the end of the course the student will be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Implement interfacing of various sensors and actuators with Arduino.	**K3**
CO2	Implement interfacing of various sensors and actuators with Node MCU.	**K3**
CO3	Design and develop smart systems using Raspberry Pi.	**K3**

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

CO-PO Mapping Table

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Arduino Cookbook_ Recipes to Begin, Expand, and Enhance Your Projects	Michael Margolis	O'Reilly Media	3e, 2020
2	Internet of Things with ESP8266-Packt Publishing	Marco Schwartz	Packt Publishing	2016
3	Internet Of things With Raspberry Pi and Arduino	Rajesh Singh, Anita Gehlot, Lovi Raj Gupta, Bhupendra Singh, Mahendra Swain	CRC Press Taylor & Francis Group	2019

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to IoT	Misra, Mukherjee, Roy	Cambridge University Press	2021
2	NodeMCU ESP8266 Communication Methods and Protocols_Programming with Arduino IDE	Manoj R. Thakur	Amazon Media EU S.à r.l	2018
3	Raspberry Pi and MQTT Essentials	Dhairya Parikh	Packt	2022
4	Electronics Projects with the ESP8266 and ESP32_ Building Web Pages, Applications, and WiFi Enabled Devices	Neil Cameron	Apress	2021

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://archive.nptel.ac.in/courses/128/108/128108016/

Continuous Assessment (25 Marks)

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

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

2. Conduct of Experiments (7 Marks)

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

3. Lab Reports and Record Keeping (6 Marks)

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

4. Viva Voce (5 Marks)

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

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

Evaluation Pattern for End Semester Examination (50 Marks)

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

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

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

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

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

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

4. Viva Voce (10 Marks)

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

5. Record (5 Marks)

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

SEMESTER S6
MINI PROJECT: SOCIALLY RELEVANT PROJECT

Course Code	**24SJPCERP608**	**CIE Marks**	50
Teaching Hours/Week (L:T:P:R)	0:0:0:3	**ESE Marks**	50
Credits	2	**Exam Hours**	NA
Prerequisites (if any)	None	**Course Type**	Project

Preamble: The objective of this course is to apply the fundamental concepts of Engineering discipline principles for the effective development of an application/research project. Mini project enables the students to boost their skills, widen the horizon of thinking and their ability to resolve real life problems. The students are expected to design and develop a software/hardware project to innovatively solve a real-world problem.

Course Assessment Method

(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	**Project Guide**	**Evaluation by the Committee** (will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, work knowledge and involvement)	**Project Report**	**Total**
5	**15**	**20**	**10**	**50**

End Semester Examination Marks (ESE)

Presentation	Demonstration	Viva	**Total**
20	**20**	**10**	**50**

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Identify technically and economically feasible problems of social relevance	**K3**
CO2	Identify and survey the relevant literature for getting exposed to related solutions	**K3**
CO3	Perform requirement analysis and identify design methodologies and develop adaptable and reusable solutions of minimal complexity by using modern tools and advanced programming techniques	**K3**
CO4	Prepare technical report and deliver presentation	**K3**
CO5	Apply engineering and management principles to achieve the goal of the project	**K3**

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

CO-PO Mapping Table:

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

Course Plan

Student Groups with 3 or 4 members should identify a topic of interest in consultation with Faculty/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Innovative design concepts, performance, scalability, reliability considerations, aesthetics/ergonomic, user experience and security aspects taken care of in the project shall be given due weight.

The progress of the mini project is evaluated based on a minimum of two reviews. The review committee may be constituted with the Head of the Department or a senior faculty, Mini Project coordinator and project guide as the members. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects

taken care of in the project shall be given due weight. The internal evaluation shall be made based on the progress/outcome of the project, reports and a viva-voce examination, conducted internally by a 3-member committee. A project report is required at the end of the semester. The product/application has to be demonstrated for its full design specifications.

Guidelines for the Report preparation

A bonafide report on mini project shall be submitted within one week after the final presentation. Minimum number of pages should be 40.

- Use Times New Roman font for the entire Report – Chapter / Section Title –Times New Roman 18, Bold; Heading 2 – Times New Roman 16, Bold; Heading 3 – Times New Roman 14, Bold; Body- Times New Roman12, Normal.
- Line Spacing – Between Heading 2 – 3 lines, between lines in paragraph 1.5 lines.
- Alignments – Chapter / Section Title – Center, Heading 2 & 3 should be Left Aligned. Ensure that all body text is paragraph justified.
- Figures & Tables – Ensure that all Figures and Tables are suitably numbered and given proper names/headings. Write figure title under the figure and table title above the table
- Suggestive order of documentation:

  i. Top Cover
  ii. Title page
  iii. Certification page
  iv. Acknowledgement
  v. Abstract
  vi. Table of Contents
  vii. List of Figures and Tables
  viii. Chapters
  ix. Appendices, if any
  x. References/Bibliography