गोंय विद्यापीठ
ताळगांव पठार,
गोंय - ४०३ २०६
फोन : + ९१ - ८६६९६०९०४८

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(Accredited by NAAC with Grade A+)

GU/Acad –PG/BoS -NEP/2026-27/206 Date: 09.07.2026

CIRCULAR

Ref. No.: GU/Acad –PG/BoS -NEP/2024/538 dated 24.09.2024
GU/Acad –PG/BoS -NEP/2025-26/267 dated 24.07.2025

In continuation to the above referred Circulars, the syllabus for Semester V & VI of the **Bachelor of Engineering in Electronics and Computer Science** Programme as approved by the Academic Council in its meeting held on 20th February 2026 is attached.

The Dean, Faculty of Engineering and Principals of affiliated Colleges offering the **Bachelor of Engineering in Electronics and Computer Science** Programme are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

ASHWIN V LAWANDE
Digitally signed by ASHWIN V LAWANDE
Date: 2026.07.09 17:38:30 +05'30'

(Ashwin V. Lawande)
Deputy Registrar – Academic

To,

1. The Dean, Faculty of Engineering, Goa University.
2. The Principals of Affiliated Engineering Colleges.

Copy to:

1. Chairperson, BoS in Electronics & Computer Engineering, Goa University.
2. Controller of Examinations, Goa University.
3. Assistant Registrar Examinations (Technical and Allied), Goa University
4. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

ELECTRONICS AND COMPUTER SCIENCE AY 2024-25

SEMESTER - V							
Sr. No	**Course Category**	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**TCr**
1	**Major**	**ECS-300**	Database Management System	2	0	0	2
		ECS-301	Database Management Systems and Data Analytics Lab	0	0	2	2
2	**Major**	**ECS-302**	VLSI Technology and Design	2	0	0	2
		ECS-303	VLSI Technology and Design Lab	0	0	2	2
3	**Major**	**ECS-304**	Analog Electronics and Instrumentation	3	0	0	3
		ECS-305	Analog Electronics and Instrumentation Lab	0	0	1	1
4	**Major**	**ECS-306**	Computer Organization and Operating Systems	4	0	0	4
5	**Prof. Electives**	**ECS-321**	Image Processing and Computer Vision	3	0	0	3
		ECS-322	Image Processing and Computer Vision Lab	0	0	1	1
		OR					
		ECS-323	Robotics	3	0	0	3
		ECS-324	Robotics Lab	0	0	1	1
		OR					
		ECS-325	Design and Analysis of Algorithms	3	0	0	3
		ECS-326	Design and Analysis of Algorithms Lab	0	0	1	1
			TOTAL	**14**	**0**	**6**	**20**

Approved by: Academic Council on 20th February 2026

SEMESTER - VI							
Sr. No	**Course Category**	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**TCr**
1	**Major**	**ECS-307**	Fundamentals of Software Engineering	2	0	0	2
		ECS-308	AR-VR and Full Stack Development Lab	0	0	2	2
2	**Major**	**ECS-309**	Industrial Automation and Process control	2	0	0	2
		ECS-310	Industrial Automation and Embedded Systems Lab	0	0	2	2
3	**Major**	**ECS-311**	Computer Networks	3	0	0	3
		ECS-312	Computer Networks Lab	0	0	1	1
4	**Major**	**ECS-313**	Principles of Communication Systems	3	0	0	3
		ECS-314	Principles of Communication Systems Lab	0	0	1	1
5	**Prof. Electives**	**ECS-327**	Control System Engineering	4	0	0	4
		OR					
		ECS-328	Transmission Lines and Antennas	4	0	0	4
		OR					
		ECS-329	AI and its applications	4	0	0	4
			TOTAL	**14**	**0**	**6**	**20**

SEMESTER V

Major Courses

Name of the Programme : B.E. in Electronics and Computer Science
Course Code : ECS-300
Title of the Course : Database Management System
Number of Credits : 02
Effective from AY : 2024-25

Prerequisites for the Course:	Knowledge of data structures, algorithms and programming	
Course Objectives:	**The course aims to provide the student with:** 1. An understanding of core database concepts, architectures, and data modelling principles 2. Skills to design conceptual and relational schemas using ER/EER models 3. The ability to use SQL and relational algebra for database creation and querying 4. Knowledge to evaluate transaction control, concurrency techniques, and NoSQL systems	
Contents:		**No of Hours**
UNIT- 1	**Introduction:** Characteristics of Database approach, advantages of using the DBMS approach, Three schema architecture, Data Models. **Data Modelling Using the Entity-Relationship (ER) Model:** Using High-Level Conceptual Data Models for Database Design, Entity Types, Entity Sets, Attributes, and Keys Relationship Types, Relationship Sets, Roles, and Structural Constraints Weak Entity Types, ER Diagrams, Naming Conventions, and Design Issues	**07**
UNIT- 2	**Relational Model Concepts:** Relational Model Constraints and Relational Database Schemas, Update Operations, Transactions, and Dealing with Constraint Violations **Relational Database Design by ER-to- Relational Mapping:** Relational Database Design Using ER-to-Relational Mapping **The Relational Algebra:** Unary Relational Operations: SELECT and PROJECT, Relational Algebra Operations from Set Theory, Binary Relational Operations**:** JOIN and DIVISION	**08**

UNIT- 3	**Basic SQL:** SQL Data Definition and Data Types, Specifying Constraints in SQL, Basic Retrieval Queries in SQL, INSERT, DELETE and UPDATE statements in SQL. **More SQL:** Complex Queries, Nested Queries, Aggregate Operators **Basics of Functional Dependencies and Normalization for Relational Databases:** Functional Dependencies, Normal Forms- First, Second and Third, Boyce-Codd Normal Form **Relational Database Design Algorithms and Further Dependencies**: Inference Rules, Equivalence, and Minimal Cover	**08**
UNIT- 4	**Transaction processing concepts:** Concepts of transaction processing, ACID properties, characterizing schedules based on recoverability, characterizing schedules based on serializability. **Concurrency Control Techniques:** Two-Phase Locking Techniques for Concurrency Control, **Getting started with NoSQL:** NoSQL, why NoSQL? SQL vs NoSQL, ACID vs BASE.	**07**
Pedagogy:	Interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills	
References/ Readings:	**TEXTBOOKS:** 1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, 6th Edition, McGraw Hill, 2013, ISBN: 007123151X 2. Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database Systems, 7th Edition, Pearson, 2018, ISBN-13: 9780133970777 **REFERENCE BOOKS:** 1. Raghu Ramakrishnan, Johannes Gehrke, Database Management Systems, 3rd Edition, McGraw-Hill, 2002, ISBN 10: 9780072465631 2. Seema Archarya, Demystify NoSQL, 1st Edition, Wiley, ISBN 10: 9788126579969	
Course Outcomes:	**Upon completion of the course, students will be able to**: CO 1. Explain database concepts and use ER modeling to design conceptual schemas. CO 2. Apply relational algebra and SQL to create, manipulate, and query databases. CO 3. Analyze transaction processing, concurrency control, and compare relational vs. NoSQL systems. CO 4. Develop ER/EER models, analyze dependencies, and normalize schemas for efficient design.	

Name of the Programme : **B.E. in Electronics and Computer Science**
Course Code : **ECS-301**
Title of the Course : **Database Management Systems and Data Analytics Lab**
Number of Credits : **02**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Programming knowledge , Basics of data structures and algorithms	
Course Objectives:	**The course aims to provide the student with**: 1. Understand core database concepts, including data models, schemas, and applications. 2. Design and implement databases based on application requirements. 3. Perform data preprocessing, exploration, visualization, and transformation on real-world datasets. 4. Apply basic statistical and foundational machine learning techniques for data-driven analysis and decision-making.	
Contents:	**List of Programs /Experiments**	**No of Hours**
	Database Management Systems 1. SQL Queries 2. SQL clauses 3. Data manipulation Language (DML) 4. Aggregate Functions in SQL 5. Set Operations in SQL 6. SQL Joins 7. MYSQL Triggers 8. MYSQL Views 9. MongoDB Setup and CRUD Operations 10. Aggregation and Indexing in MongoDB **Data Analytics** 11. Data Import, Cleaning, and Preparation 12. Exploratory Data Analysis (EDA) on a Given Dataset 13. Data Visualization Techniques Using Matplotlib/Seaborn 14. Statistical and Correlation Analysis of Datasets 15. Data Transformation and Feature Engineering Techniques 16. Linear Regression Model Implementation 17. Logistic Regression Model Implementation 18. Decision Tree Classifier Implementation and Evaluation 19. Apache Spark – Basic Data Analysis (PySpark/Spark SQL)	**60**

	20. MapReduce Simulation for Word Count in Python	
Pedagogy:	Integration of instructional learning, constructive thinking, inquiry-based, Collaborative, experiential, and problem-solving approaches.	
References/ Readings:	**TEXTBOOKS:** 1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, 6th Edition, McGraw Hill, 2013, ISBN-0-07123151-X 2. Raj Kamal and Preeti Saxena, Big Data Analytics, 1st Edition, McGraw Hill Education (India) Pvt. Ltd, 2020, ISBN 13: 9789353164966 3. Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database Systems, 7th Edition, Pearson, 2018, ISBN-13: 978-0133970777 4. V.K. Jain, Data Science and Analytics, 1st edition, Khanna Publishing House, 2021, ISBN 10: 93-86173670 **REFERENCE BOOKS:** 1. Jure Leskovec, Anand Rajaraman, and Jeffrey D. Ullman, Mining of Massive Datasets, 3rd Edition, Cambridge University Press, 2020, ISBN: 9781108471791 2. Raghu Ramakrishnan, Johannes Gehrke, Database Management Systems, 3rd Edition, McGraw-Hill, 2002, ISBN 10: 978-0072465631 3. Seema Archarya, Demystify NoSQL, 1st Edition, Wiley, ISBN10: 978 8126579969	
Course Outcomes:	**Upon completion of the course, students will be able to:** CO 1. Explain core concepts of relational and NoSQL databases, including SQL and MongoDB architectures. CO 2. Use SQL and MongoDB to create, query, and manage databases using appropriate operations and constraints. CO 3. Perform data import, cleaning, exploration, visualization, and statistical analysis on real-world datasets. CO 4. Implement basic machine learning models and introductory Big Data techniques to analyze data and support decision-making.	

Name of the Programme : **B.E in Electronics and Computer Science**
Course Code : **ECS-302**
Title of the Course : **VLSI Technology and Design**
Number of Credits : **2**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Knowledge of semiconductors, basic electronics and digital logic.	
Course Objectives:	**The course aims to provide the student with:** 1. A foundation in IC technology, MOS device behaviour, modern VLSI technology nodes, and transistor-level characteristics. 2. An Insight into CMOS inverter behaviour, design constraints, power aspects, and switching characteristics. 3. An Exposure to CMOS logic families, transmission-gate-based implementations, and latch/register design. 4. Familiarity with FPGA architecture, design flow, testing methodologies, fault models, and ATPG concepts.	
Content:		**No of Hours**
UNIT 1	Introduction to integrated circuit technology, The integrated circuit (IC) era, VLSI Design Flow. Meta oxide-semiconductor (MOS) and related VLSI technology, nMOS & CMOS fabrication: n-well, Comparison of bipolar and CMOS technology. Basic Structure of **FinFET** and Cross Section of FinFET. List of VLSI Tech nodes (10um to 3nm) **MOS transistors:** Structures, MOS system under external bias, operation of MOS transistor (MOSFET), Threshold voltage MOSFET current-voltage characteristics (CGA), channel length modulation, substrate bias effect. **Measurements of parameters** - K_N, V_{TO} & γ.	**9**
UNIT 2	**CMOS inverter design:** Operation, DC characteristics, Calculation of V_{IL}, V_{IH}, V_{TH}, V_{OH} and V_{OL}. Noise margins, power and area considerations. **Switching Circuit Characteristics:** Rise, fall and delay time, gate delays, Transistor sizing, Fan-out/Fan-in, Static and Dynamic Power Dissipations.	**7**
UNIT 3	**CMOS transistor switches:** CMOS logic-Inverter, NOR, NAND and Combinational logic, Compound gates, Boolean Expressions using CMOS logic. **Transmission gates:** Multiplexers, Basic logic gates, Latches and Registers. Implementation of Boolean Expressions using transmission gates.	**7**

UNIT 4	**FPGA Fundamentals:** Overview, FPGA Types, SRAM-Based FPGA Architecture, FPGA Design Flow, FPGA Selection Categories. **VLSI Testing:** Introduction, Importance, Fault models, Fault simulation, Design for Testability, Ad Hoc Testing, scan test, Boundary scan test, Built-in self test. **Automatic Test Pattern Generation –** Introduction, Reasons, Process, Combinational Stuck-At-Fault.	**7**
Pedagogy:	Interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills	
References/ Readings:	**TEXTBOOKS** 1. Alfred L. Crouch, Design-for-Test for Digital IC's and Embedded Core Systems, 1st Edition, Prentice Hall PTR, 2008, ISBN: 9780130848277 2. Neil Weste, David Harris, CMOS VLSI Design: A Circuits and Systems Perspective, 3rd Edition, Pearson, 2004, ISBN: 9780321149015 3. R.C. Cofer and Ben Harding Rapid system Prototyping with FPGAs, 1st Edition, Elsevier, 2006, ISBN: 9780750678667 4. Sung-Mo (Steve) Kang, Yusuf Leblebici; CMOS Digital Integrated Circuits Analysis & Design, 3rd Edition, McGraw-Hill Education, 2003, ISBN: 9780072460537 **REFERENCES** 1. Jan M. Rabaey, Digital Integrated Circuits - A Design perspective, 2nd Edition, Pearson Education, 2003, ISBN: 9780131207646 2. L.T. Wang, C.W. Wu, and X. Wen, VLSI Test Principles and Architectures,1st Edition, Morgan Kaufmann, 2006, ISBN: 9780123705976 3. Samar K.Saha, FinFET Devices for VLSI Circuits and Systems, 1st Edition, CRC Press, 2020, ISBN: 9781138586093 4. Wayne Wolf, Modern VLSI design (Systems on Silicon), 2nd Edition, PHI, 2008, ISBN: 9780137145003	
Course Outcomes:	**Upon completion of the course, students will be able to:** CO 1. Analyze MOS structures, device characteristics, threshold behavior, and short-hannel effects using VLSI technology principles. CO 2. Evaluate CMOS inverter performance in terms of logic thresholds, noise margins, propagation delays, power dissipation, and sizing rules. CO 3. Design CMOS logic gates, compound structures, transmission-gate circuits and simple sequential elements based on Boolean requirements. CO 4. Apply FPGA design steps and examine VLSI testing approaches including fault models, scan techniques, BIST, and ATPG for combinational faults.	

Name of the Programme : **B.E in Electronics and Computer Science**
Course Code : **ECS-303**
Title of the Course : **VLSI Technology and Design Lab**
Number of Credits : **2**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Knowledge of semiconductos, basic electronics, C programming and digital logic.	
Course Objectives:	**The course aims to provide the student with:** 1. Practical skills in HDL-based digital design, including RTL modeling, verification, and FPGA implementation. 2. Ability to analyze device and circuit behavior using SPICE and TCAD tools. 3. Exposure to VLSI design automation, covering HLS, logic synthesis, timing, and physical design tools. 4. Knowledge of layout creation, verification, and basic Design-for-Test (DFT) techniques.	
Content:	**List of Experiments**	**No of Hours**
	<u>FRONT-END RTL DESIGN & FUNCTIONAL VERIFICATION (using tools like Icarus, Xilinx Vivado, etc.)</u> 1. **RTL Design: Combinational Circuit** Design a combinational circuit using gatelevel, dataflow and behavioral modelling. 2. **Self-Checking Testbench for 4×1 MUX** Develop a complete automated testbench using $display to report pass/fail status. 3. **Sequential Circuits** Implement synchronous sequential logic using procedural blocks and clock edges. 4. **Structural Modeling: 4-bit Ripple-Carry Adder** Create a hierarchical design by instantiating four Full-Adder modules. 5. **FPGA Implementation of Ripple-Carry Adder** Load the Combinational Circuit onto the FPGA; verify its functionality using switches and LEDs. **<u>CIRCUIT PHYSICS & SPICE SIMULATION (using tools like LT SPICE, etc.)</u>** 1. **MOSFET V_T and I–V Characterization** Obtain I_{DS}–V_{GS} and I_{DS}–V_{DS} characteristics and extract the threshold voltage. 2. **CMOS Inverter Voltage Transfer Characteristic (VTC)**	**60**

	Perform a DC sweep, plot the VTC, and determine V_{IH}, V_{IL}, V_{OH}, V_{OL}. 3. **CMOS Inverter Delay Analysis** Measure rise time, fall time, t_{pHL}, t_{pLH}, and propagation delay. **DEVICE-LEVEL SIMULATION (using tools like Silvaco TCAD, etc.)** 1. **CMOS Fabrication Process Simulation** Simulate oxidation, diffusion, implantation, annealing, and generate device cross-section. 2. **MOSFET Device Simulation** Extract I–V and C–V characteristics; determine V_{TH}, mobility, and channel parameters. **HIGH-LEVEL SYNTHESIS (HLS USING tools like BAMBU, etc.)** 3. **Introduction to HLS: C to HDL RTL** Convert a simple C function into synthesizable RTL; analyze FSM & datapath. 4. **Loop Unrolling & Pipelining Optimization** Apply loop unrolling, pipelining, and compare latency and throughput. 5. **Resource Sharing & Area Optimization** Optimize arithmetic operations through sharing and binding; compare area reports. **LOGIC SYNTHESIS & STATIC TIMING ANALYSIS (using tools like YOSYS, OPENSTA, etc.)** 1. **RTL-to-Gate-Level Synthesis** Generate gate-level netlist and observe technology mapping. 2. **Logic Optimization (opt passes)** Apply constant folding, dead logic elimination, and structural optimizations. 3. **Clock Constraint Definition, Basic Timing Analysis, Critical Path & Worst Negative Slack Identification** Define SDC clock constraints and generate timing reports. Analyze timing paths, compute WNS, and identify the critical path. **MANUAL LAYOUT DESIGN (using tools like Electric VLSI Design, magic, etc.)** 1. **CMOS Inverter Layout** Create layout, perform DRC, extract the netlist, and simulate post-layout behavior. 2. **2-Input CMOS NAND Gate Layout** Use shared diffusion, complete DRC, and extract the layout netlist.	

	PHYSICAL DESIGN & DFT (using tools like OPENROAD, KLAYOUT, etc.) 1. **Complete Physical Design Flow** Run floorplanning, placement, CTS, and routing for the synthesized design. 2. **Floorplan Utilization Analysis** Compare 50% vs 90% utilization and study congestion/ routability.	
Pedagogy:	Experiential Learning, Tool-Based Learning with Industry-Standard EDA Platforms, Layered Learning Approach, Collaborative and Peer-Learning Approach	
References/ Readings:	**TEXTBOOKS** 1. R.C. Cofer and Ben Harding; Rapid system Prototyping with FPGAs, 1st Edition, Elsevier, 2006, ISBN: 9780750678667 2. Samir Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, 2nd Edition, Pearson, 2003, ISBN: 9788177589184 **REFERENCES** 1. Sung-Mo (Steve) Kang. Yusuf Leblebici, CMOS Digital Integrated Circuits Analysis & Design, 3rd Edition, McGraw-Hill Education, 2003, ISBN: 9780072460537	
Course Outcomes:	**Upon completion of the course, students will be able to:** CO 1. Analyze MOSFETs, CMOS circuits, and power-delay characteristics using SPICE simulations and TCAD modeling. CO 2. Develop and verify RTL designs in Verilog, create self-checking testbenches, and validate hardware on FPGA platforms. CO 3. Generate optimized RTL and gate-level netlists with HLS and logic synthesis tools, and evaluate timing using static timing analysis. CO 4. Implement layouts using Magic, perform DRC/LVS checks, execute full physical design flows with OpenROAD and apply basic DFT techniques.	

Name of the Programme : **B.E. in Electronics and Computer Science**
Course Code : **ECS-304**
Title of the Course : **Analog Electronics and Instrumentation**
Number of Credits : **03**
Effective from AY : **2024-25**

Prerequisites for the Course:	Knowledge of Elements of Electrical and Electronics Engineering	
Course Objectives:	**The course aims to provide the student with**: 1. An understanding of the fundamental principles, configurations, and limitations of operational amplifiers and phase-locked loops (PLL). 2. The ability to design op-amp circuits, A/D and D/A converters, and 555 timer-based circuits. 3. Knowledge of the working and applications of measuring instruments and transducers. 4. Skills to apply theoretical concepts in designing and analyzing analog and mixed-signal electronic circuits.	
Content:		**No of Hours**
UNIT- I	**Differential Amplifiers:** Differential amplifiers, ac and dc analysis, constant current bias, current mirror circuit. **Basics of Op-Amp:** Functional block diagram, op-amp definitions, equivalent circuit of Op- amp, voltage transfer curve, Open loop Configurations: Inverting, non- inverting & differential amplifier, Disadvantages of open loop op-amp. Closed loop Configurations: Inverting and non-inverting amplifiers, Frequency response of op-amp **Applications of Op-amp:** Differentiator, Integrator, Summing scaling and averaging amplifier	**12**
UNIT-2	**Applications of Op-amp:** Op-Amps as comparators, Schmitt trigger, Sample and hold circuit, Instrumentation amplifier. **Filters using Op-Amp:** Butterworth low pass, high pass, band pass, band reject filter (Analysis & design). **Oscillators using Op-Amp:** Wien bridge and Phase shift oscillators (Analysis & design). **Data converters**: Resolution, accuracy, quantization error in convertors, DAC: Binary weighted resistors and R-2R resistor ladder (Analysis & Design), ADC: Successive approximation	**12**
UNIT-3	**Special ICs: Timer IC 555** - Functional block diagram, working, specification and modes: IC 555 as monostable and astable multivibrator (Analysis & design), applications of IC555 as monostable (missing pulse detector, frequency divider, PWM)	**10**

	and a stable multivibrator (Square wave oscillator, free running ramp generator). **PLL**: Functional block diagram, working, transfer characteristics of PLL, lock range and capture range (no derivations). Applications of PLL as frequency multiplier, PLL IC 565	
UNIT-4	**Instrumentation:** Characteristics of Instruments: Static and Dynamic characteristics, Errors in measurement. **Digital Voltmeter:** Dual Slope Integrating Type, Successive Approximation Type DVMs **DSO:** Block diagram of DSO **Signal Generators:** Block diagram of Function generator and Spectrum Analyzer **Temperature Transducers:** Resistance Temperature Detectors, Thermistors, Thermocouples. **Displacement Transducers:** Strain Gauge, Linear Variable Differential Transformer.	**11**
Pedagogy:	Interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills	
References/ Readings:	**TEXT BOOKS:** 1. H. S. Kalsi, Electronic Instrumentation, 3rd Edition, Tata McGraw Hill, 2014, ISBN 9780070702066 2. Ramakant A. Gayakwad, Op-Amps and linear integrated circuits,4th edition, Prentice Hall India Pvt. Ltd, 2012, ISBN 9788120320581 **REFERENCE BOOK** 1. K. R. Botkar, Integrated Circuits, 10th edition, Khanna Publishers, 2004, ISBN 8174092080	
Course Outcomes:	**Upon completion of the course, students will be able to:** CO 1. Explain working of linear and non-linear applications of an op-amp CO 2. Explain working of Instruments and Transducers CO 3. Analyze the functionality of differential and operational amplifiers and design practical amplifier circuits. CO 4. Design circuits using Data Converters, IC 555 timer and PLL	

Name of the Programme : **B.E. in Electronics and Computer Science**
Course Code : **ECS-305**
Title of the Course : **Analog Electronics and Instrumentation Lab**
Number of Credits : **01**
Effective from AY : **2024-25**

Prerequisites for the Course:	Basics of Electrical and Electronics Engineering	
Course Objectives:	**The course will enable students to:** 1. Understand and implement various Op-Amp configurations 2. Understand and implement linear and nonlinear applications of operational amplifiers 3. Acquire the knowledge and implement special function ICs 4. Understand the working and characteristics of LVDT and temperature transducers used for measuring displacement and temperature	
Content:	**List of Programs /Experiments**	**No of Hours**
	1. Design and analyze Op-Amp open loop and closed loop Configuration 2. Design and analyze Op-Amp as Summing, Scaling, and Averaging Amplifier 3. Design and analyze Op-Amp as an Integrator and Differentiator 4. Design and analyze an active High pass filter, Low pass filter and Band pass filter using operational amplifier 5. Design IC 555 Timer in Astable and Monostable Mode 6. Design and Analyze Voltage Regulators using LM317/ LM723/ IC78XX/ 79XX 7. Design digital to analog converter circuits using Weighted Resistor / R-2R ladder 8. To design and analyze a Schmitt Trigger using operational amplifier 9. Analysis of linear variable displacement transducer 10. Determination of RTD transducer characteristics	**30**
Pedagogy:	Integration of instructional learning, constructive thinking, inquiry-based, collaborative, experiential, and problem-solving approaches	
References/ Readings:	**TEXTBOOKS** 1. H. S. Kalsi; Electronic Instrumentation, 3rd edition, Tata McGraw Hill, 2014, ISBN 9780070702066 2. James Fiore, Operational Amplifiers & Linear Integrated Circuits + Lab Manual, Milne Open Text Books, ISBN13: 978-1796855623 3. Ramakant A. Gayakwad, Op-Amps and linear integrated circuits,4th edition, Prentice Hall India Pvt. Ltd, 2012, ISBN 9788120320581	

	REFERENCE BOOKS 1. K. R. Botkar, Integrated Circuits, 10th edition, Khanna Publishers, 2004, ISBN 8174092080
Course Outcomes:	**Upon completion of the course, students will be able to:** CO 1. Explain the working of displacement and temperature transducers CO 2. Design and verify op amp configurations. CO 3. Design and verify op amp linear and non-linear applications. CO 4. Design and verify voltage regulator and timer circuits using standard ICs

Name of the Programme : **B.E. in Electronics and Computer Science**
Course Code : **ECS-306**
Title of the Course : **Computer Organization and Operating Systems**
Number of Credits : **4**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic of C, C++ Programming, Logic Design	
Course Objectives:	**The course aims to provide the student with**: 1. An understanding of the structure, function, and characteristics of computer systems, including memory and I/O fundamentals. 2. A comprehensive knowledge of operating system principles, techniques, and approaches. 3. The ability to explain process synchronization, scheduling algorithms, deadlocks, and memory management concepts, including virtual memory. 4. An understanding of file management, disk scheduling policies, and overall OS resource management.	
Contents		**No of hours**
UNIT-1	**Introduction to Computer Organization:** Computer components, Functions, interconnection Structure, Bus Interconnection, Register organization, Instruction Cycle, Instruction Pipelining: Strategy, Performance and Hazards **Memory System:** Basic concepts, Characteristics, Hierarchy, Semiconductor RAM Memories, Internal Organization of Memory Chip, Read-Only Memories. Cache Memory Principles, Elements of Cache Design. **Input/Output:** External Devices, I/O Modules, Programmed I/O, Interrupt-Driven I/O, Direct Memory Access.	**15**
UNIT-2	**Operating System:** OS objectives and functions, Services provided, Kernel, Booting, Multiprocessor system, Multiprogramming System, time sharing system **Process management:** Process concepts, process states, creation & termination of processes, two & five model process model, suspended process, inter-process communication, Thread overview, Multithreading models **Concurrency Control:** Principles of concurrency, operating system concerns, process interaction, competition amongst processes for resources, cooperation amongst processes by sharing & communication.	**15**
UNIT-3	**Process Scheduling:** Basic concepts: CPU – I/O Burst Cycle, CPU Scheduler, Pre-emptive Scheduling, Dispatcher, Scheduling criteria, Scheduling Algorithms: FCFS, SJF, Priority, RR	**15**

	Process Synchronization: Background, The Critical – Section Problem, Synchronization Hardware, Semaphores, classic problems of Synchronization: The Bounded Buffer Problem, the Readers-Writers Problem, The Dining-Philosophers Problem **Deadlocks:** System model, deadlock characterization, methods for handling deadlocks, deadlock prevention, deadlock avoidance, deadlock detection, recovery from deadlock.	
UNIT-4	**Memory Management:** Requirements, Memory Partitioning: Fixed Partitioning, Dynamic Partitioning, Memory Allocation Strategies: Best-Fit, First Fit, Worst Fit, Paging and Segmentation **Virtual Memory:** Background, Demand Paging, Page Replacement: Basic Scheme, FIFO, Optimal, LRU, Allocation of frames, Thrashing: cause of Thrashing. **File Management:** Files, File Management Systems, File Organization and access, File Directories, File Sharing, Record Blocking. **Secondary Storage Structure:** Introduction, Disk Scheduling Algorithms.	**15**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	**TEXTBOOKS:** 1. Andrew S Tanenbaum, Modern Operating Systems, 3rd Edition, Prentice Hall India Pvt Ltd, 2013, ISBN-9788120339040 2. M. Morris Mano, Computer Organization and Architecture,3rd Edition, Dorling, Kindersley (India) Pvt Ltd, 2011, ISBN-9788131700709 3. William Stallings, Computer Organization and Architecture, 6th Edition, Dorling, Kindersley (India) Pvt Ltd, 2011, ISBN-9788131732458 4. William Stallings; Operating Systems: Internal & design principles, 6th Edition, Pearson Education,2012, ISBN-9788131725283. **REFERENCES:** 1. Achyut S. Godbole, Atul Kahate, Operating Systems, 3rd Edition, Tata McGraw Hill Education Pvt Ltd, 2012. ISBN-9788131700709 2. Silberschatz, Abraham; Galvin, Peter Baer, Gagne, Greg, Operating Systems Concepts,8th Edition, Wiley, 2012, ISBN-9788126520510	
Course Outcomes:	**Upon completion of the course, students will be able to**: CO 1. Explain operating systems, process management, and concurrency control. CO 2. Describe memory management, virtual memory, file organization, and disk scheduling policies. CO 3. Apply process scheduling algorithms and techniques for process synchronization and deadlock handling. CO 4. Analyze computer system organization, memory hierarchy, and input/output functionalities.	

Professional Electives

Name of the Programme : B.E in Electronics and Computer Science
Course Code : ECS-321
Title of the Course : Image Processing and Computer Vision
Number of Credits : 03
Effective from AY : 2024-25

Prerequisites for the Course:	Linear Algebra, Basics of Signal Processing	
Course Objectives:	**The course aims to provide the student with:** 1. An understanding of visual perception and the effects of image sampling and quantization. 2. Knowledge of image degradation and restoration processes. 3. Skills to apply spatial filtering and edge detection techniques for image enhancement and segmentation. 4. The ability to apply morphological operations and image compression techniques for higher-level image processing applications.	
Content:		**No of Hours**
UNIT- 1	**Introduction to Digital image processing**: Scope, Fundamental Steps, Components, Applications, Visual Perception, Brightness adaptation and discrimination, Simple Image Formation model, Image sampling and quantization, Spatial and Intensity Resolution, Some Basic relationships between pixels, Enhancement using arithmetic and logical operations, Geometric Transformations **Spatial Domain Enhancement:** Some basic intensity transformation functions (Image Negatives, Logarithmic and Power-Law Transformation, Thresholding, Contrast stretching, Intensity-level slicing, Bit plane slicing), Histogram Processing: Equalization, matching)	**12**
UNIT-2	**Spatial filtering:** Fundamentals of spatial filtering, Filter Kernels, Smoothing and Sharpening spatial filters, Unsharp masking and High boost filtering **Image Transforms:** Orthogonal and Unitary Transforms, 2-D Discrete Fourier Transform and Properties, Hadamard-Walsh, Discrete cosine transform (DCT) **Enhancement in Frequency domain:** Introduction, Basic filtering in the frequency domain, Smoothing and Sharpening filters, Homomorphic filtering.	**11**

UNIT -3	**Image Restoration:** Model of the Image degradation/Restoration process, Noise models, Restoration in the Presence of Noise only: Mean Filters, Order Statistics, Adaptive filters, Inverse Filtering, Wiener filtering **Colour image processing:** Colour fundamentals, Colour models (RGB, CMYK, HSI). **Image Compression:** Fundamentals, Image Compression Models, Image Formats, Huffman Coding, Golomb Coding, Arithmetic Coding, RLE, LZW, Block Transform Coding	**11**
UNIT -4	**Introduction to Computer Vision:** Definition and scope, Difference between Image Processing & Computer Vision **Morphological Image Processing:** Introduction, Erosion and Dilation, Opening and Closing, The Hit-or-Miss transformation, Boundary extraction, hole filling, thinning and thickening **Segmentation:** Fundamentals, Point, Line, and Edge detection, Edge linking using Local and Global Processing, Thresholding, Segmentation by Region Growing and by Region Splitting and Merging **Feature Extraction & Description:** Chain codes, Boundary Feature Descriptors, Basic Region Feature Descriptors, Topological Descriptors	**11**
Pedagogy:	Interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills	
References/ Readings:	**TEXT BOOKS** 1. Anil K. Jain, Fundamentals of Digital Image Processing Pearson, 1st Edition, 2002, ISBN: 978-9332551916 2. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, 4th Edition, Pearson, 2010, ISBN: 9780982085417 **REFERENCES** 1. Kenneth R. Castleman, Digital Image Processing,1st Edition, Pearson, 2006, ISBN: 9780131891190 2. Milan Sonka, Vaclav Hlavac and Roger Boyle, Image Processing, Analysis and Machine Vision, 2nd Edition, Brooks/Cole, 1999, ISBN: 9780534953935 3. S. Jayaraman, S. Esakkirajan and T. Veerakumar, Digital Image Processing, 11th Reprint, 3rd Edition, McGraw Hill Education, 2013, ISBN: 9780071070904 4. S. Sridhar, Digital Image Processing, 2nd Edition, Oxford University Press, 2011, ISBN: 9780198070501 5. William K. Pratt, Digital Image Processing, 4th Edition, John Wiley, 2007, ISBN: 9780471374075	

Course Outcomes:	**Upon completion of the course, students will be able to**: CO 1. Explain fundamental concepts of digital image processing and basic enhancement techniques. CO 2. Apply spatial and frequency-domain methods for image enhancement. CO 3. Analyze image degradation and implement restoration, color processing and compression techniques. CO 4. Evaluate and apply morphological, segmentation, and feature extraction methods for computer vision tasks.

Name of the Programme : **B.E. in Electronics and Computer Science**
Course Code : **ECS-322**
Title of the Course : **Image Processing and Computer Vision Lab**
Number of Credits : **1**
Effective from AY : **2024-25**

Pre- requisites for the Course:	Applied Mathematics, Python Programming	
Course Objectives:	**This course will enable students to:** 1. Implement basic image processing techniques using OpenCV. 2. Apply spatial and frequency-domain operations through practical coding. 3. Perform segmentation, feature extraction, and morphological operations on real images. 4. Gain hands-on experience in restoration, compression, and enhancement techniques.	
Contents:	**List of Programs /Experiments**	**No of Hours**
	1. Image Processing in Open CV 2. Image Sampling and Quantization 3. Affine Transformation on Images 4. Image Enhancement Techniques A. Negation, Logarithmic and Power-Law B. Histogram Based Processing C. Bit-Plane Slicing, Contrast Stretching and Intensity Slicing 5. Spatial Filtering (Smoothing, sharpening) 6. Frequency Domain Transforms 7. Frequency Domain Filtering (Smoothing, sharpening) 8. Image Restoration 9. Image Compression and Coding 10. Image Morphological Operations 11. Image Segmentation 12. Feature Extraction	**30**
Pedagogy:	Integration of instructional learning, constructive thinking, inquiry-based, collaborative, experiential, and problem-solving approaches.	
References/ Readings:	**TEXT BOOKS** 1. Anil K. Jain, Fundamentals of Digital Image Processing, 1st Edition, Pearson, 2002, ISBN: 978-9332551916 2. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, 4th Edition, Pearson, 2010, ISBN: 9780982085417 **REFERENCES** 1. Kenneth R. Castleman, Digital Image Processing, 1st Edition, Pearson,	

	2006, ISBN: 9780131891190 2. Rafael C. Gonzalez, Richard E. Woods and Steven Eddins, Digital Image Processing Using MATLAB, 2nd Edition, Pearson, 2011, ISBN: 9780070702622 3. S. Jayaraman, S. Esakkirajan and T. Veerakumar, Digital Image Processing, 2nd Edition, McGraw Hill Education, 2013, ISBN: 9780071070904 4. S. Sridhar, Digital Image Processing, 2nd Edition, Oxford University Press, 2011, ISBN: 9780198070501.
Course Outcomes:	**Upon completion of the course, students will be able to**: CO 1. Understand basic image processing concepts and operations. CO 2. Apply spatial and frequency-domain filtering techniques to real images. CO 3. Analyze and extract image features for introductory computer vision tasks. CO 4. Implement image segmentation, restoration, compression, morphological operations, and other processing techniques using OpenCV/Python.

Name of the Programme : **B.E in Electronics and Computer Science**
Course Code : **ECS-323**
Title of the Course : **Robotics**
Number of Credits : **03**
Effective from AY : **2024-25**

Prerequisites for the Course:	Knowledge of AC and DC Motors	
Course Objectives:	**The course aims to provide the student with:** 1. An understanding of the subsystems and components of robotic systems. 2. Skills to select suitable sensors, actuators, and end effectors for robots. 3. Competence in analyzing kinematics and motion planning in robotic systems. 4. Knowledge to apply machine vision techniques and understand legged and wheeled mobile robots	
Content:		**No of Hours**
UNIT- 1	**Basic Concepts in (Fundamentals of) robotics:** Automation and robotics, Robot applications. **Different classifications of robot:** By application, by coordinate system, by actuation system, by control method and by programming method. **Robot anatomy:** links and joints, Joint notation scheme. Degree of Freedom. Robot resolution, accuracy and repeatability. Concept of workspace. **Robot End Effectors**: Grippers and Tools.	**12**
UNIT-2	**Drive systems:** Pneumatic and hydraulic systems. Electric: Relation between torque and voltage. AC and DC Servo motors, Stepper motors, BLDC motors. Electronic control of motors. **Sensors:** Characteristics of a sensor, Classification of Sensors, Touch sensors, Position Sensors: Potentiometer, LVDT, Optical Encoders, Force/Moment sensors, Range Sensor, Proximity Sensors- Inductive sensor, capacitive sensor, Hall effect sensor.	**11**
UNIT -3	**Kinematics:** Coordinate frames, mapping and transforms, description of objects in space, transformation of vectors, fundamental rotation matrices, Direct Kinematic model: Kinematic modelling of manipulator. **Inverse Kinematics:** Solvability of inverse kinematic models, solution techniques, closed form solution.	**11**

	Trajectory planning: Definitions and planning tasks, joint space techniques, cartesian space techniques, joint space v/s cartesian space.	
UNIT -4	**Machine Vision:** Introduction, Sensing, Digitizing function, Imaging devices, Lighting techniques, Image storage, Image processing and analysis, Image Data reduction, Segmentation, Feature extraction, Object recognition, Training the vision system, Robotic applications. **Introduction to mobile robots:** Introduction, Legged Mobile Robots, Wheeled Mobile Robots.	**11**
Pedagogy:	Interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills	
References/ Readings:	**TEXTBOOKS:** 1. M. P. Groover, M. Weiss, R. N. Nagel, N. G. Odrey, Industrial Robotics Technology: programming and Applications, 1st Edition, McGrawHill, 1986, ISBN: 9780070221543 2. S. K. Saha, Introduction to Robotics, 2nd Edition, McGrawHill, 2008, ISBN: 9780070141109 **REFERENCES:** 1. John J. Craig, Introduction to Robotics, Mechanics & Control, 3rd Edition, Pearson Education,2004, ISBN-10: 0201543613 2. Mittal & Nagrath, Robotics and Control, 1st Edition, McGraw-Hill, 2017, ISBN-10: 0070482934 3. Peter Corke, Robotics Vision and Control, Springer, 2nd Edition, 2017, ISBN- 10: 3319544128 4. Roland Siegwart, Illah R. Nourbakhsh, Introduction to Autonomous Mobile Robots, 2nd Edition, MIT Press, 2011, ISBN-10: 0262015358	
Course Outcomes:	**Upon completion of the course, students will be able to** : CO 1. Explain the principles of actuation systems, sensors, robot architectures, applications, and control techniques. CO 2. Implement machine vision techniques for object recognition in robotic applications. CO 3. Solve problems related to robot specifications, actuators, kinematics, and control. CO 4. Evaluate suitable end effectors, sensors, and motion strategies for specific robotic applications.	

Name of the Programme : **B.E in Electronics and Computer Science**
Course Code : **ECS-324**
Title of the Course : **Robotics Lab**
Number of Credits : **01**
Effective from AY : **2024-25**

Prerequisites for the Course:	Basics of Programming	
Course Objectives:	**The course aims to provide the student with:** 1. An understanding of electronic control techniques for actuators, including DC servo, stepper, and BLDC motors. 2. Skills to program and interface sensors and camera modules 3. The ability to design and implement robotic systems, such as obstacle detection and line-following robots. 4. Foundational knowledge of robotic kinematics, including forward and inverse kinematics for manipulators.	
Content:	**List of programs/ Experiments**	**No of Hours**
	1. Electronic Control of a DC Servo motor 2. Electronic Control of a Stepper motor 3. Electronic control of BLDC motor 4. Interfacing of proximity and range sensors to Arduino/R-Pi 5. Interfacing of IMU sensors like Gyroscopes and Accelerometers to Arduino/R-Pi 6. Interfacing of force sensors to Arduino/R-Pi 7. Interfacing of camera module to Arduino/R-Pi 8. Line following robot 9. Forward kinematics of a robot 10. Inverse kinematics of a robot	**30**
References/ Readings:	**TEXTBOOKS:** 1. M. P. Groover, M. Weiss, R. N. Nagel, N. G. Odrey, Industrial Robotics: Technology, Programming and Applications, 1st Edition McGraw Hill, 2007, ISBN: 9780070221543 2. S. K. Saha, Introduction to Robotics, 2nd Edition, McGraw Hill, 2017, ISBN: 9780070141109	
Course Outcomes:	**Upon completion of the course, students will be able to:** CO 1. Implement DC servo, stepper, and BLDC motors using electronic circuits and microcontrollers. CO 2. Develop sensor-based applications by interfacing proximity and range sensors with Arduino or Raspberry Pi.	

	CO 3. Analyze and compute forward and inverse kinematics for simple robotic arms to determine joint parameters and end-effector positions. CO 4. Design and build autonomous robotic modules, such as obstacle detection systems and line-following robots.

Name of the Programme : **B.E. in Electronics and Computer Science**
Course Code : **ECS-325**
Title of the Course : **Design and Analysis of Algorithms**
Number of Credits : **3**
Effective from AY : **2024-25**

Pre- requisites for the Course:	Basic knowledge of programming, Knowledge of data structures.	
Course Objectives:	**This course will enable students to:** 1. Understand the fundamental concepts of algorithm design and performance analysis. 2. Apply mathematical methods to analyze algorithm efficiency using asymptotic notations and recurrence relations. 3. Develop efficient algorithms using design paradigms such as divide and conquer, greedy, and dynamic programming. 4. Explore advanced problem-solving techniques including backtracking, branch and bound, and approaches for dealing with NP-hard and NP-complete problems.	
Contents:		**No of Hours**
Unit - 1	**Algorithm Analysis & Complexity:** Algorithm definition, specification, correctness, Growth of functions, rate of growth, Performance measures: Time complexity, Space complexity, Asymptotic notation, Worst-case, average-case, amortized analysis. **Recurrence Relations:** Substitution/Iteration method, Recursion tree method, Master theorem. **Divide and Conquer:** Binary search, Merge sort, Quick sort, Finding min-max, Finding k-th smallest element, Strassen's matrix multiplication.	**12**
Unit - 2	**Greedy Method:** General method, knapsack Problem, Minimum cost spanning tree, single source shortest path. **Dynamic Programming:** General method, multistage graphs, All-pairs shortest paths, Single source shortest path with general weights, Optimal binary search tree, 0/1 knapsack problem, travelling salesperson problem.	**12**
Unit - 3	**Backtracking:** General method, 8-queens problem, Sum of subsets problem, graph colouring, Hamiltonian Cycles, knapsack problem. **Branch and Bound:** General method, 0/1 knapsack, Travelling Salesperson problem.	**11**

Unit - 4	**String and Pattern Matching Algorithms:** Brute force, KMP, Boyer-Moore, tries; **Text compression:** Huffman coding; **Text similarity testing:** LCS. **NP-Hard and NP-Complete Problems:** Basic concepts, NP-hard graph problems (clique decision problem), randomized, probabilistic and approximation algorithms.	**10**
Pedagogy:	Interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills	
References/ Readings:	**Textbooks:** 1. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, Fundamentals of Computer Algorithms, 2nd Edition, Galgotia Publications, 2008, ISBN: 9788175152571. 2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms, 3rd Edition, MIT Press / McGraw-Hill, 2009, ISBN: 9780262033848. **Reference Books:** 1. Gilles Brassard, Paul Bratley, Fundamentals of Algorithmics, 1st Edition, Prentice-Hall of India, 1996, ISBN: 9780133350689. 2. Jon Kleinberg, Éva Tardos, Algorithm Design, 1st Edition, Pearson Education, 2005, ISBN: 9780321295354. 3. Michael T. Goodrich, Roberto Tamassia, Algorithm Design: Foundations, Analysis, and Internet Examples, 2nd Edition, Wiley, 2006, ISBN: 9788126509867.	
Course Outcomes:	**Upon completion of the course, students will be able to:** CO 1. Explain the fundamentals of algorithm analysis and various complexity measures CO 2. Apply divide and conquer, greedy, and dynamic programming approaches to solve computational problems CO 3. Analyze and evaluate algorithmic solutions for optimization using backtracking and branch-and-bound methods CO 4. Design and justify efficient algorithms for NP-hard problems using heuristic, randomized, or approximation algorithms	

Name of the Programme : **B.E. in Electronics and Computer Science**
Course Code : **ECS-326**
Title of the Course : **Design and Analysis of Algorithms Lab**
Number of Credits : **1**
Effective from AY : **2024-25**

Pre- requisites for the Course:	Basic knowledge of programming, understanding of fundamental data structures, and familiarity with implementing them**.**	
Course Objectives:	**This course will enable students to**: 1. Implement and analyze the performance of fundamental algorithms. 2. Apply various algorithm design paradigms such as Divide and Conquer, Greedy, Dynamic Programming, Backtracking, and Branch and Bound. 3. Compare algorithmic approaches based on computational efficiency and problem characteristics. 4. Develop programming skills to design and evaluate algorithms for complex computational problems.	
Contents:	**List of Programs /Experiments**	**No of Hours**
	1. Write a program to implement binary search using divide and conquer. 2. Write a program to implement merge sort using divide and conquer. 3. Write a program to implement quick sort using divide and conquer. 4. Write a program to implement minimum cost spanning tree using the greedy approach. 5. Write a program to implement single source shortest path algorithm using the greedy approach. 6. Write a program to implement 0/1 knapsack problem using dynamic programming. 7. Write a program to implement optimal binary search tree (OBST) using dynamic programming. 8. Write a program to implement single source shortest path algorithm using dynamic programming (Bellman-Ford). 9. Write a program to implement sum of subsets problem using backtracking. 10. Write a program to implement graph colouring problem using backtracking. 11. Write a program to implement pattern matching algorithms. 12. Write a program to implement text compression and text similarity testing.	**30**

Pedagogy:	Integration of instructional learning, constructive thinking, inquiry-based, collaborative, experiential, and problem-solving approaches.
References/ Readings:	**TEXTBOOKS:** 1. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, Fundamentals of Computer Algorithms, 2nd Edition, Galgotia Publications, 2008, ISBN: 9788175152571 2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms, 3rd Edition, MIT Press / McGraw-Hill, 2009, ISBN: 9780262033848 **REFERENCE BOOKS**: 1. Gilles Brassard, Paul Bratley, Fundamentals of Algorithmics, 1st Edition, Prentice-Hall of India, 1996, ISBN: 9780133350689. 2. Jon Kleinberg, Éva Tardos, Algorithm Design, 1st Edition, Pearson Education, 2005, ISBN: 9780321295354. 3. Michael T. Goodrich, Roberto Tamassia, Algorithm Design: Foundations, Analysis, and Internet Examples, 2nd Edition, Wiley, 2006, ISBN: 9788126509867.
Course Outcomes:	**Upon completion of the course, students will be able to**: CO 1. Apply divide-and-conquer, greedy, and dynamic programming paradigms to solve computational problems experimentally. CO 2. Evaluate and compare algorithm performance using time and space complexity measures. CO 3. Implement and test basic algorithms using different design techniques in a programming environment. CO 4. Design and implement heuristic, randomized, or approximation-based solutions for NP-hard and complex problems.

SEMESTER VI

Major Courses

Name of the Programme : B.E in Electronics and Computer Science
Course Code : ECS-307
Title of the Course : Fundamentals of Software Engineering
Number of Credits : 2
Effective from AY : 2024-25

Pre-requisites for the Course:	Object Oriented Programming using Java, Database Management system	
Course Objectives:	**The course aims to provide the student with:** 1. Understand fundamental software life-cycle models, requirement gathering, and basic UML representations. 2. Learn core software testing concepts, including basic techniques and test case design. 3. Understand defect prevention strategies and perform basic control flow–based testing. 4. Gain an overview of commonly used software testing tools and the role of software maintenance.	
Content:		**No of Hours**
Unit 1	**Software Life-Cycle Models:** Code-and-Fix Life-Cycle Model, Waterfall Life-Cycle Model, Rapid-Prototyping Life-Cycle Model, Open Source Life-Cycle Model, Agile Processes, Spiral Life-Cycle Model **More on UML:** Class Diagrams, Use-Case Diagrams, Activity Diagrams. **Requirements:** Determining what the Client Needs, Overview of the Requirements Workflow, Understanding the Domain, Initial Requirements.	**7**
Unit 2	**Testing:** Non-Execution-Based Testing, Execution-Based testing. **Testing Techniques:** Test Case Selection, Black-Box Unit-Testing Techniques, Integration Testing, Product Testing, Acceptance Testing. **Post-delivery Maintenance:** Development and Maintenance, Management of Post-delivery Maintenance.	**8**
Unit 3	**Defect Prevention and Process Improvement:** Basic concepts and generic approaches, Defect prevention techniques. **Control Flow:** Basic Control Flow Testing.	**7**

Unit 4	**Software testing tools and overview:** Need for automated testing tools, Taxonomy of testing tools, Functional/Regression testing tools, Performance testing tools, Testing management tools, Source code testing tools, Selection of testing tools. **Case study:** Overview of Win Runner, Silk Test, SQA Robot, Load runner.	**8**
Pedagogy	Interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills	
References/ Readings:	**TEXTBOOKS:** 1. Dr. K.V.K.K. Prasad, Software Testing Tools, 1st Edition, Dreamtech Press India Pvt. Ltd. 2004, ISBN-13: 9788177225327 2. Jeff Tian, Software Quality Engineering – Testing, Quality Assurance and Quantifiable Improvement, 1st Edition, Wiley, 2006, ISBN-10: 0471713457 3. Stephen R. Schach, Object-Oriented and Classical Software Engineering, 8th Edition, TMH, 2010, ISBN: 9780073376189 **REFERENCE BOOKS:** 1. Kshirasagar Naik, Priyadarshi Tripathy, Software Testing and Quality Assurance: Theory and Practice, 1st Edition, Wiley Publications. 2008, ISBN-10: 047178911 2. Roger Pressman, Software Engineering: A Practitioner's Approach, 7th Edition, McGraw-Hill, 2010, ISBN-10: 0073375977	
Course Outcomes:	**Upon completion of the course, students will be able to**: CO 1. Explain software life-cycle models and create simple UML diagrams and requirement specifications CO 2. Describe and apply basic defect prevention techniques and conduct basic control flow testing. CO 3. Demonstrate understanding of automated testing tools and explain key concepts of software maintenance. CO 4. Apply basic execution and non-execution testing methods, including black-box and integration testing.	

Name of the Programme : **B.E in Electronics and Computer Science**
Course Code : **ECS-308**
Title of the Course : **AR-VR and Full Stack Development Lab**
Number of Credits : **02**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Fundamentals of computer graphics, basics of programming usingC++, python, web technology	
Course Objectives:	**The course aims to provide the student with:** 1. An understanding of essential tools and technologies used in AR, VR, MR, and full-stack development. 2. Skills to create and manipulate 3D objects, scenes, and interactive AR/VR experiences using Unity, AR Foundation, Blender, and XR Interaction Toolkit. 3. The ability to develop secure, database-driven web applications using Python, Django, REST frameworks, and CRUD operations. 4. Competency to deploy full-stack applications and demonstrate end-to-end functionality in real-world scenarios.	
Contents:	**List of Programs /Experiments**	**No of Hours**
	AR-VR 1. Study of AR/VR development tools such as Unity, AR Foundation, XR Interaction Toolkit, Blender, and Unity Asset Store. 2. Create and manipulate 3D primitive objects and apply camera projections to understand scene composition. 3. Import 3D models from Unity Asset Store and apply lighting, materials, and visual effects to enhance realism. 4. Model simple 3D objects using Blender and import them into Unity; apply textures, materials, and shaders. 5. Create an interactive AR application using AR Foundation with plane detection and virtual object placement. 6. Add audio, text, and particle effects to AR objects to create enhanced AR experiences. 7. Develop VR-enabled applications using Unity XR Interaction Toolkit with simulated controllers. 8. Develop an AR application with educational interactivity such as virtual walkthroughs or e-learning visualizations. 9. Create AR-based visualization applications such as human anatomy, architecture preview, or science models (DNA/RNA, solar system, etc.). 10. Develop a simple MR-inspired interactive mini-game using Unity's AR + VR interaction concepts (screen-based VR + AR object placement).	**60**

	Full Stack Development 11. To install Python, set up a virtual environment, and initialize a basic Django project. 12. To demonstrate the MVT architecture by configuring URL routing and creating function-based views. 13. To implement Django Templates (DTL) and configure static files for frontend rendering. 14. To define database schemas using Django Models and perform database migrations. 15. To configure and customize the Django Admin interface for effective data management. 16. To implement Django Forms for securely handling and validating user input data. 17. To develop a fully functional application performing CRUD (Create, Read, Update, Delete) operations. 18. To implement user authentication (Login/Logout) and access control using Django's built-in system. 19. To create simple API endpoints and serializers using the Django REST Framework (DRF). 20. To deploy the completed Django application onto a live hosting platform.	
Pedagogy:	Integration of instructional learning, constructive thinking, inquiry-based, Collaborative, experiential, and problem-solving approaches.	
References/ Readings:	**TEXTBOOKS:** 1. Antonio Mele, Django 4 By Example: Build Powerful and Reliable Python Web Applications, 4th Edition, Packt Publishing, 2022, ISBN:9781801813051 2. Schmalstieg, Hollerer, Augmented Reality: Principles & Practice, 1st Edition, Pearson Education, 2016, ISBN-10: 9332578494 3. Sanni Siltanen, Theory and applications of marker-based augmented reality, 1st Edition, Julkaisija – Utgivare Publisher, 2012, ISBN: 9789513874490 4. William R Sherman and Alan B Craig, Understanding Virtual Reality, Interface Application and Design, 1st Edition, Morgan Kaufmann Publishers, 2002, ISBN: 1558603530 5. William S. Vincent, Django for Beginners: Build Websites with Python and Django, 4th Edition, WelcomeToCode Publishing, 2023, ISBN-10:1735467200 **REFERENCE BOOKS:** 1. Alan B Craig, William R Sherman, Jeffrey D Will, Developing Virtual Reality Applications: Foundations of Effective Design, 1st Edition, Morgan Kaufmann Publishers, 2009, ISBN: 9780123749437 2. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, 1st Edition, Morgan Kaufmann, 2013, ISBN: 978 0240824109	

	3. Burdea, Grigore C and Philippe Coiffet, Virtual Reality Technology, 3rd Edition, Wiley, 2003, ISBN: 9780471388263 4. Gastón C. Hillar, Django RESTful Web Services: Build Powerful Web APIs with Python and Django, 1st Edition, Packt Publishing, 2018, ISBN : 9781788835572 5. Jeff Forcier, Paul Bissex, and Wesley J. Chun, Python Web Development with Django, 1st Edition, Addison-Wesley Professional, 2008, ISBN: 0132356139
Course Outcomes:	**After completing this course, students will be able to**: CO 1. Describe the features and tools of Unity, AR Foundation, XR Interaction Toolkit, and Blender for creating 3D objects and AR/VR scenes. CO 2. Apply Django's MVT architecture to build web applications using templates, models, forms, authentication, CRUD operations, and REST API endpoints. CO 3. Develop functional AR and VR applications by implementing plane detection, object placement, UI overlays, multimedia effects, and VR interaction mechanics. CO 4. Deploy and evaluate Django applications on hosting platforms to ensure proper functionality, usability, and end-to-end system performance.

Name of the Programme : **B.E in Electronics and Computer Science**
Course Code : **ECS-309**
Title of the Course : **Industrial Automation and Process Control**
Number of Credits : **2**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Analog and Digital Electronics	
Course Objectives:	**The course aims to provide the student with:** 1. Understanding of process control principles and sensor technologies 2. Knowledge of signal conditioning, actuators, and controller operations 3. Exposure to automation using programmable logic controllers 4. Understanding of industrial interfacing standards	
Contents:		**No of Hours**
UNIT- 1	**Introduction to Process Control:** Introduction; control systems; process control block diagram **Sensors:** Sensor time response. Overview of Thermal sensors: RTD, thermistors, thermocouples. Overview of Mechanical sensors: Strain, motion, pressure, and flow. Pressure and flow.	**7**
UNIT-2	**Analog signal conditioning:** Linearization, Conversion Final Control: Introduction; final control operation; Signal conversion. **Actuators:** Electrical: stepping motor, pneumatic, and hydraulic; **Control elements:** Mechanical; Electrical **Controller Principles:** Introduction; process characteristics, Control system parameters; basics of continuous controller modes: proportional, integral, derivative control modes	**8**
UNIT -3	**Programmable Logic Controllers (PLCs):** Parts of a PLC, Principles of Operation, PLCs versus Computers, **Basic PLC Programming:** Processor Memory Organization, Program Scan, Ladder Programming, Concepts of latching, interlocking, jogging outputs via ladder programming. **PLC Timers:** Timer instructions, ON delay timer instruction, Off-Delay timer instruction, Retentive Timer **PLC Counters:** Counter Instructions, Up-counter, down counter, Up-Down counter, Combining counter and timer functions, examples of timer and counter functions for industrial applications.	**8**

UNIT -4	SCADA systems: Introduction and brief history of SCADA, Modern SCADA systems, Remote terminal units. Data logger basics, Advantages of data loggers, anatomy of a data logger, types of data loggers, factors to be considered in selecting a data logger. Basic standards: RS-232 and RS-485, Electrical signal characteristics, Modbus: General overview, Modbus protocol structure.	**7**
Pedagogy:	Interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills kills	
References/ Readings:	**TEXTBOOKS** 1. Curtis D. Johnson, Process Control and Instrumentation Technology, 7th Edition, Pearson Education, 2004, ISBN: 8178088444 2. John Webb, Ronal Weiss, Programmable Logic Controllers: Principles & Applications, 5th Edition, Prentice Hall of India, 2002, ISBN 13: 9780130416728 3. Programmable Logic Controllers, Frank Petruzzula, 4th Edition, Tata Mc-Graw Hill, 2010, ISBN-13: 978-1265150495 **REFERENCES** 1. C. Rangan, G. Sarma, V. Mani, Instrumentation Devices and Systems, 2nd edition, TMH, 2017, ISBN No. 13: 978-0070678200. 2. Clarke, G., Reynders, D., Wright, E., Practical Modern SCADA Protocols, 1st Edition, Newnes,2004, ISBN 9780750679930 3. Deon Reynders, Steve Mackay, Edwin Wright, Practical Industrial Data Communications: Best Practice Techniques, 1st Edition, Newnes , Elsevier,2004, ISBN 9780750665391 4. S. K. Singh; Industrial Instrumentation and control, 3rd Edition, TMH, 2009, ISBN: 9780070262225	
Course Outcomes:	**After going through this course, the students will be able to:** CO 1. Explain process control fundamentals, sensors, and signal conditioning concepts CO 2. Describe actuator types, control elements, and basic controller modes CO 3. Apply PLC programming concepts including timers, counters, and ladder logic CO 4. Analyze SCADA systems, data loggers and evaluate and use industrial communication standards	

Name of the Programme : **B. E in Electronics and Computer Science**
Course Code : **ECS-310**
Title of the Course : **Industrial Automation and Embedded Systems Lab**
Number of Credits :**2**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Fundamental knowledge of electrical circuits, logic design, basic control systems principles, Microprocessor and Microcontroller	
Course Objectives:	**The course aims to provide the student with**: 1. Fundamental knowledge of sensors (thermal, optical, motion) and signal-conditioning techniques. 2. Practical skills in data acquisition, visualization, and controls 3. Competencies in designing and configuring PLC- and SCADA-based industrial automation systems. 4. Understanding and hands-on experience with ARM processors, including assembly instructions, architecture, registers, CPSR flags, and interfacing external peripherals such as LEDs, switches, displays, motors, and PWM modules.	
Contents:	**List of Programs /Experiments**	**No of Hours**
	Industrial Automation 1. Linear variable differential transducer and Strain gauge 2. Capacitive transducer and pressure transducer 3. Implementation of logic gates using PLC 4. Implementation of latching, interlocking & jogging using plc 5. Implementation of ladder programs for timing applications 6. Implementation of ladder programs for counter applications 7. Loops using LabVIEW 8. Virtual instruments sub vi using LabVIEW 9. Structures using LabVIEW 10. PI, PD & PID controller implementation **Embedded Systems** 11. Programs on Basic Data Movement Instructions 12. Programs on Arithmetic Operations 13. Programs on Logical and Bitwise Operations 14. Programs on Conditional Execution & Flags 15. Programs on Looping and Iteration 16. Interfacing of LED and Switch with the ARM development board 17. Implement PWM using the ARM development board 18. Interfacing of LCD with the ARM development board	**60**

	19. Interfacing of seven segment display with the ARM development board 20. Interfacing of Motor with the ARM development board	
Pedagogy:	Integration of instructional learning, constructive thinking, inquiry-based, collaborative, experiential, and problem-solving approaches.	
References/ Readings:	**TEXTBOOKS** 1. ARM System Developer's Guide: Designing and Optimizing System Software,1st Edition, Morgan Kaufmann Pub, 2004, ISBN-13: 9781558608740 2. Curtis D. Johnson; Process Control and Instrumentation Technology, 7th Edition; Pearson Education, 2004, ISBN: 8178088444 3. John Webb, Ronal Weiss; Programmable Logic Controllers: Principles & Applications, 5th Edition; Prentice Hall of India,2002, ISBN 13: 9780130416728 4. Programmable Logic Controllers, Frank Petruzzula; Tata Mc-Graw Hill 1st Edition,2010, ISBN-13: 978-1265150495 **REFERENCES** 1. ARM Assembly Language: Fundamentals and Techniques,2nd Edition, CRC Press, 2014, ISBN-13: 9781482229851 2. C. Rangan, G. Sarma, V. Mani, Instrumentation Devices and Systems, 2nd edition, TMH,2017, ISBN-13: 978-0070678200. 3. Deon Reynders, Steve Mackay, Edwin Wright; Practical Industrial Data Communications: Best Practice Techniques,1st Edition, Newnes, An imprint of Elsevier,2004, ISBN 9780750665391 4. S. K. Singh, Industrial Instrumentation and control, 1st Edition, TMH, 2010, ISBN: 9780070678200	
Course Outcomes:	**Upon completion of the course, students will be able to**: CO 1. Interface input/output peripherals such as LEDs, switches, LCDs, seven-segment displays, PWM modules, and motors with an ARM controller for embedded applications. CO 2. Apply ARM assembly instructions for data manipulation, arithmetic and logical operations, and implement conditional execution and looping using CPSR flags. CO 3. Analyze and apply the working principles of transducers and virtual instruments for practical applications. CO 4. Design and implement industrial automation systems using PLC programming, and analyze PID-based control strategies.	

Name of the Programme : **B.E. in Electronics and Computer Science**
Course Code : **ECS-311**
Title of the Course : **Computer Networks**
Number of Credits : **03**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Mathematics, Basic computer fundamentals	
Course Objectives:	**The course aims to provide the student with**: 1. An introduction to the concept of OSI model, TCP/IP, identifying different network topologies and protocols. 2. An understanding of Data Link layer protocols and technologies. 3. Application of fundamental concepts of network layer operations, routing algorithms, and Internet protocols (IPv4/IPv6), including addressing, subnetting, VLANs, NAT. 4. A comprehensive understanding of transport-layer services and mechanisms, along with key application-layer protocols and architectures such as DNS, E-mail, and the World Wide Web	
Contents:		**No of Hours**
UNIT- 1	Reference Models: Layered architecture of OSI Model, TCP/IP architecture. **Line coding:** NRZ, RZ, Biphase (Manchester and Differential Manchester), AMI, HDB3, B8ZS, 2BIQ, 8B6T. **LAN**: **LAN topologies**: Bus, Ring, Tree, Star, Ethernet: Types, Contention Access, CSMA, CSMA/CD, Token ring, fast ethernet The Physical Layer: Interface RS-232, DTE-DCE interface.	**10**
UNIT-2	**Data Link Layer:** Frame design consideration, flow control, error control (stop- and-wait mechanism, sliding window), sequence numbering of piggybacking acknowledgement. **Data Link protocols:** BISYNC- transmission frames, protocol operation, HDLC- flow and error control, framing, transparency, protocol operation, Comparison of BISYNC and HDLC. **Switching:** Switching networks, circuit switching, space division switching, Time division switching, packet switching (datagram and virtual circuit –SVC and PVC)	**12**
UNIT -3	**Networking Devices:** Repeaters, Bridges, Hub, Switch, Routers, Gateways, Firewall. **Network Layer:** Services, virtual circuits and datagram subnet, routing algorithms (shortest path, flooding, flow based, distance vector, link state), congestion control, choke packets,	**11**

	load shedding, jitter control, flow specifications, traffic shaping (leaky bucket and token bucket algorithm) **Internet Protocols:** IPv4 (Classful and Classless Addressing) Sub-netting, VLAN, NAT, IPv6, Address Mapping: ARP, DHCP, ICMP	
UNIT -4	**Transport Protocols:** Transport service: services provided to the upper layer, connection establishment, connection release, multiplexing, flow control and buffering **Application Layer:** Domain Name System: DNS Name Space, Resource Records, Name Servers; Electronic Mail: Architecture and Services, The User Agent, Message Formats, Message Transfer, Final Delivery; World Wide Web: Architectural Overview, Client and Server Side, URLs, Cookies; HTTP: Connections, methods, message headers, caching	**12**
Pedagogy:	Interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills	
References/ Readings:	**TEXTBOOKS:** 1. Andrew S Tanenbaum, Nick Feamster, David J Wetherall, Computer Networks, 6th Edition, Pearson, 2021, ISBN: 9780136681557 2. Behrouz A Forouzan, Data Communications and Networking, 5th Edition, McGraw Hill Education, 2017, ISBN: 9781259096468 3. Prakash C Gupta, Data Communications and Computer Networks, 2nd Edition, PHI Learning, 2014, ISBN: 9788120348646 **REFERENCE BOOKS:** 1. Achyut S Godbole, Data Communications and Networks, 2nd Edition, McGraw Hill Education, 2017, ISBN: 9780071077705 2. William Stallings, Data and Computer Communications, 10th Edition, Pearson, 2013, ISBN: 9780132126953	
Course Outcomes:	**Upon completion of the course, students will be able to:** CO 1. Explain layered communication models, data transmission techniques, line coding schemes, LAN architectures, and physical layer interfaces. CO 2. Explain the transport-layer services including connection management and multiplexing, and describe application-layer protocols such as DNS, Email, WWW, and HTTP. CO 3. Analyze data link layer protocols, framing, flow/error control mechanisms, frame sequencing, and compare switching techniques including circuit, packet, and message switching. CO 4. Evaluate the functions of networking devices, apply routing algorithms and demonstrate understanding of IPv4/IPv6 addressing and address mapping protocols.	

Name of the Programme : **B.E. in Electronics and Computer Science**
Course Code : **ECS-312**
Title of the Course : **Computer Networks Lab**
Number of Credits : **01**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Fundamental Networking Concepts and Programming Skills	
Course Objectives:	**The course aims to provide the student with:** 1. An understanding of the various line coding schemes in communication networks. 2. An understanding of the working principle of various communication protocols with respect to the OSI model. 3. Analysis of the various data communication algorithms. 4. An understanding of the concept of data transfer between nodes in a network.	
Contents:	**List of Programs /Experiments**	**No of Hours**
	Line Encoding (Using OCTAVE/PYTHON/MATLAB) 1. Implement Unipolar NRZ & NRZ-L and NRZ-I encoding techniques 2. Implement RZ and Bi-phase (Manchester and Differential Manchester) encoding techniques 3. Implement Bipolar Encoding schemes (AMI, Pseudo ternary, B8ZS and HDB3) **Networking Configuration: (Using Network Simulator/Cisco Packet Tracer)** 4. Setting up a network to study various Topologies 5. Configuration of LAN 6. Configuring Networking and Internetworking Devices such as Hub, Switch, Router, Bridge 7. Inter-Network Data Exchange Setup 8. VLAN Creation and Verification and Switch Connection for VLAN Expansion 9. Configuration of Routing Information protocol 10. Configuration of Open shortest Path First (OSPF) Algorithm 11. Network Configuration with Static & Default Routing	**30**
Pedagogy:	Integration of instructional learning, constructive thinking, inquiry-based, Collaborative, experiential, and problem-solving approaches.	
Instructions:	List of experiments to be performed from above list.	

References/ Readings:	**TEXTBOOKS:** 1. Andrew S Tanenbaum, Nick Feamster, David J Wetherall, Computer Networks, 6th Edition, Pearson, 2021, ISBN: 9780136681557 2. Behrouz A Forouzan, Data Communications and Networking, 5th Edition, McGraw Hill Education, 2017, ISBN: 9781259096468 3. Prakash C Gupta, Data Communications and Computer Networks, 2nd Edition, PHI Learning, 2014, ISBN: 9788120348646 **REFERENCE BOOKS:** 1. Achyut S Godbole, Data Communications and Networks, 2nd Edition, McGraw Hill Education, 2017, ISBN: 9780071077705 2. William Stallings, Data and Computer Communications, 10th Edition, Pearson, 2013, ISBN: 9780132126953
Course Outcomes:	**After going through this course, the students will be able to**: CO 1. Analyse various data communication protocols CO 2. Implement various topologies in a computer network CO 3. Implement line coding techniques for computer networks CO 4. Configure networking devices to set up communication between the same.

Name of the Programme : **B.E. in Electronics and Computer Science**
Course Code : **ECS-313**
Title of the Course : **Principles of Communication Systems**
Number of Credits : **03**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basics of Signal Processing, Analog and Digital Electronics	
Course Objectives:	**The course aims to provide the student with**: 1. An understanding of fundamental concepts of analog and digital modulation techniques. 2. Knowledge about the sampling process, pulse modulation and multiplexing. 3. An understanding of the functions of a communication transmitter and receiver. 4. The ability to analyze and compare various analog and digital modulation schemes	
Contents:		**No of Hours**
UNIT- I	**An Overview of Electronic Communication Systems:** Block Diagram Representation, Analog vs. Digital Communication, Need for Frequency Translation - Modulation and Multiplexing, Types of Transmission Media. Signal Multiplexing: Frequency Division Multiplexing & Time Division Multiplexing **Analog Modulation: Amplitude Modulation (AM)** – Mathematical Representation of AM signal, Modulation Index, Double Side-band Suppressed Carrier (DSB-SC)-Balanced Modulator, Coherent detection, DSB with Carrier (DSB-C)-Envelope Detector, Single Sideband Suppressed Carrier (SSB-SC) Generation: Filter Method, Phase Shift Method, The Third Method, Coherent Detection, Comparison based on Spectrum (Modulation Bandwidth) and Power Efficiency	**12**
UNIT-2	**Angle Modulation:** Frequency Modulation (FM) - Mathematical Representation of FM signal, Modulation Index, FM Spectrum, Bandwidth, Carson's Rule, Narrowband and Wideband FM (Classification). **Implementation of angle modulators and demodulators:** Direct method using FET, Armstrong method of generation. Slope detector, Foster-Seelay Discriminator, Ratio detector. **Phase Modulation (PM)** – Mathematical Representation, Relationship between FM and PM. Comparison with AM.	**11**

UNIT-3	**Sampling:** Sampling Theorem, Natural Sampling, Flat-top sampling, Signal Recovery through holding, Equalization. **Quantization of Signals:** Quantization Error, Mid-rise & Mid-tread quantizers, Uniform & Non-uniform quantizers, Companding- μ-Law and A-Law. **Pulse Modulation Techniques:** PAM, PPM and PWM **Pulse digital modulation techniques:** Pulse code modulation, Differential Pulse Code Modulation, Delta modulation, Adaptive delta modulation.	**10**
UNIT-4	**Digital Modulation:** Keying Techniques – Mathematical Representation, Generation and Reception Scheme (Block Level), and Spectrum (Nominal Bandwidth) of: Amplitude Shift Keying (ASK), Binary Phase Shift Keying (BPSK), Differential PSK (DPSK), Quadrature Phase Shift Keying (QPSK), M-ary PSK, Binary Frequency Shift Keying (BFSK), Quadrature Amplitude Shift Keying: 16-QASK. Principle and block level representation of Super heterodyne Receiver, Choice of Intermediate Frequency, Image Frequency and its rejection.	**12**
Pedagogy:	Interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills	
References/ Readings:	**TEXTBOOKS:** 1. Kennedy, G., Davis, B., Prasanna, S.R.M., Electronic Communication Systems, 5th Edition, Tata McGraw Hill,2011, ISBN 9780071077828 2. Taub, H., Schilling, D., Saha, G., Principles of Communication Systems, 3rd Edition, Tata McGraw Hill,2007, ISBN 9780070648111 **REFERENCE BOOKS:** 1. Haykin, S., Communication Systems, 4th Edition, John Wiley & Sons, 2006, ISBN 9788126509041 2. Proakis, J., Salehi, M., Fundamentals of Communication Systems,1st Edition, Pearson Education, 2007, ISBN 9788131705735 3. Singh, R.P., Sapre, S.D., Communication Systems: Analog and Digital, 3rd Edition, Tata McGraw Hill,2017, ISBN 9780070634541	
Course Outcomes:	**Upon completion of the course, students will be able to:** CO 1. Explain the fundamental principles of analog and digital communication systems CO 2. Describe and interpret the functional operation of communication transmitters and receivers. CO 3. Classify and compare various analog and digital modulation schemes based on their characteristics and performance CO 4. Analyze sampling, quantization, pulse modulation, and digital modulation techniques and evaluate their impact on system performance	

Name of the Programme : **B.E. in Electronics and Computer Science**
Course Code : **ECS-314**
Title of the Course : **Principles of Communication Systems Lab**
Number of Credits : **01**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basics of Electronics	
Course Objectives:	**This course will enable students to**: 1. Understand the practical implementation of analog and digital modulation and demodulation techniques used in communication systems. 2. Develop hands-on skills in sampling, pulse modulation, digital encoding, and multiplexing techniques through laboratory experiments. 3. Apply theoretical communication concepts to design, generate, and analyze real-time communication signals. 4. Enhance problem-solving, teamwork, and experimental analysis skills through observation, measurement, and interpretation of communication waveforms	
Contents:	***List of Programs /Experiments***	**No of Hours**
	1. Study and Implement Amplitude Modulation and Demodulation 2. Study and Implement Frequency Modulation and Demodulation 3. Perform Sampling and signal Reconstruction of analog signals. 4. Implement and analyze Pulse Amplitude Modulation. 5. Implement and analyze Pulse Code Modulation. 6. Implement and analyze Binary Phase Shift Keying. 7. Implement and analyze Binary Frequency Shift Keying. 8. Implement and analyze Quadrature Phase Shift Keying. 9. Implement and analyze Quadrature Amplitude Modulation. 10. Study and Implement Multiplexing techniques using TDM and FDM	**30**
Pedagogy:	Interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills	
References/ Readings:	**TEXTBOOKS:** 1. Kennedy, G., Davis, B., Prasanna, S.R.M., Electronic Communication Systems, 5th Edition, Tata McGraw Hill,2011, ISBN 9780071077828 2. Taub, H., Schilling, D., Saha, G., Principles of Communication Systems, 3rd Edition, Tata McGraw Hill, 2007, ISBN 9780070648111	

	REFERENCE BOOKS: 1. Haykin, S., Communication Systems, 4th Edition, John Wiley & Sons, 2006, ISBN 9788126509041 2. Proakis, J., Salehi, M., Fundamentals of Communication Systems,1st Edition,Pearson Education, 2007, ISBN 9788131705735. 3. Singh, R.P., Sapre, S.D., Communication Systems: Analog and Digital, 3rd Edition, Tata McGraw Hill, 2017, ISBN 9780070634541
Course Outcomes:	**Upon completion of the course, students will be able to:** CO 1. Apply modulation and demodulation principles to generate, detect, and analyze analog and digital communication signals. CO 2. Classify and compare various modulation schemes using time-domain and frequency-domain experimental observations. CO 3. Interpret and analyze experimental results effectively through individual and team-based activities, reinforcing fundamental communication system concepts CO 4. Design and conduct experiments to verify theoretical concepts related to sampling, pulse modulation, and digital modulation techniques

Professional Electives

Name of the Programme : B.E. Electronics and Computer Science
Course Code : ECS-327
Title of the Course : Control System Engineering
Number of Credits : 4
Effective from AY : 2024-25

Pre-requisites for the Course:	Knowledge of Mathematics	
Course Objectives:	**The course aims to provide the students with:** 1. An understanding of basic control system components, signal flow graphs, and transfer functions. 2. An ability to perform time domain analysis and evaluate stability of any given system model 3. An ability to perform frequency domain stability analysis. 4. An ability to assess compensators and controllers for a given application	
Contents:		**No of Hours**
UNIT- 1	**Introduction to control systems:** Types of control systems, Examples of Control systems, basic concept of open-loop and closed-loop control systems; Mathematical models of Control System: Mechanical translational and electrical systems. Conversion of mechanical to analogous electrical systems (force- voltage and force- current analogy); Block diagrams; Signal flow graph	**15**
UNIT-2	**Time Response Analysis:** Test Signals, Impulse Response, Order and Type of System, Transient response of first and second order systems; Time Domain Specifications, Type -0, -1 and –2 control systems. Steady state error and error constants. **Stability:** Stability concept, Location of poles on s-plane for stability, Routh- Hurwitz criterion, Root Locus	**15**
UNIT -3	**Frequency-domain Analysis:** Frequency Domain Specifications, Correlation between time and frequency response, Bode-plots, Polar-plots, Nyquist Stability Criterion and Nyquist-plots	**15**
UNIT -4	**State space variable Analysis:** State-Space formulation, state model of linear system, state diagram, State-space representation for mechanical translational and electrical systems. **Compensators:** Concept and types of compensators;	**15**

	Realization of Lead, Lag and Lead-Lag compensators using electrical networks **Controllers:** P, I, PI, PD and PID controllers. Response with P, PI, PD and PID Controllers	
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	**TEXTBOOKS:** 1. J. Nagrath and M. Gopal, Control Systems Engineering, 7th Edition The New Age International,2022, ISBN-13: 9788195175581 2. Nagoor Kani, Control Systems, RBA Publications, 3rd Edition, Chennai, 2017, ISBN-13: 9788900121230 **REFERENCE BOOKS:** 1. Anand Kumar, Control Systems, 2nd Edition, PHI Learning Pvt. Ltd, ISBN-13: 9788120349391 2. K. Jairath, Problems and Solutions of Control Systems with Essential Theory, 5th Edition, CBS Publishers and Distributors, ISBN-13: 9788194898696 3. K. Ogata, Modern Control Engineering, 5th Edition, Pearson, 2015, ISBN-13: 9789332550162 4. U. A. Bakshi, V. U. Bakshi, Control Systems, Technical Publications	
Course Outcomes:	**After going through this course, the students will be able to:** CO 1. Explain and interpret block diagrams, signal flow graphs, and state-space representations of control systems. CO 2. Analyze control systems and develop mathematical models using mechanical and electrical analogies. CO 3. Evaluate system stability and performance using time-domain and frequency-domain techniques such as Routh–Hurwitz, Root Locus, Bode, and Nyquist methods. CO 4. Design and assess controllers and compensators including P, I, PI, PD, PID, and lead/lag/lead–lag networks to meet specified performance requirements.	

Name of the Programme : **BE in Electronics and Computer Science**
Course Code : **ECS328**
Title of the Course : **Transmission Lines and Antennas**
Number of Credits : **04**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Mathematics, Soft Computing	
Course Objectives:	**The course aims to provide the student with**: 1. Ability to explain coordinate systems, fundamental laws of electrostatics and electromagnetics, transmission line theory, and antenna concepts. 2. Ability to analyze electrostatic and magnetostatic fields, along with the propagation of guided and electromagnetic waves. 3. Ability to apply electromagnetic wave equations to practical, real-world engineering problems. 4. Understanding of memory system fundamentals, including types of memory, input–output operations, and related design considerations in electromagnetics and transmission lines.	
Contents:		**No of Hours**
UNIT- 1	Review of coordinate systems and transformation: Cartesian, Circular and Spherical coordinates, Circular. Transformation from Cartesian to cylindrical and spherical coordinate system. **Vector Calculus:** Differential length, area and volume, Line, surface and volume integrals, Gradient, Divergence of a vector, Divergence Theorem, Curl of a vector, Stoke's theorem, Laplacian of a scalar, Vector Fields **Classification Electrostatics:** Coulomb's Law and field intensity, Electric Field due to continuous charge distributions (a line charge, a surface charge, a volume charge)	**15**
UNIT-2	Electrostatics: Electric Flux density, Gauss's law and its Applications Electric Potential, Relationship between E and V Maxwell's equation, electric dipole and flux lines. Magnetostatics: Biot Savart Law, Ampere's circuit law, Magnetic Field density, Maxwell's Equations for Static EM fields, Analogy between Electric and Magnetic Circuits	**15**
UNIT -3	Transmission Lines: Transmission Line Parameters & Equations, Expressions for Attenuation constant, Phase constant, velocity of propagation, Lossless Line, Terminated Lossless Line, Lossy Transmission Lines (Low-Loss Line, Distortion less Line, Terminated Lossy Lines), concept of infinite line, Input Impedance, SWR, and Power, Open- and short-circuited lines	**15**

	The Smith Chart: Applications of Transmission Lines: Quarter Wave Matching, Single-Stub Matching, Slotted Line (Impedance Measurement)	
UNIT -4	Basic Antenna Concepts– Patterns, Beam Area, Radiation Intensity, Beam Efficiency, Directivity-Gain-Resolution, Antenna Apertures, Effective Height. Fields from Oscillating Dipole, Field Zones, Front -to-back Ratio. Friss transmission formula. Introduction of point sources, Power patterns and Power theorem. Antenna Arrays: Various forms of Antenna arrays, Arrays of point sources: Isotropic point sources of: (i) same amplitude and phase (ii) same amplitude but opposite phase. Linear array: Linear array with n isotropic point sources with equal amplitude and spacing, Broadside case, End-fire case	**15**
Pedagogy:	Interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills	
References/ Readings:	**TEXTBOOKS:** 1. J.D. Kraus, Antennas and Wave Propagation, 5th Edition, McGraw Hill Education, 2010, ISBN: 9789352606184 2. M. Sadiku, Elements of Electromagnetics, 4th edition, Oxford University Press,2006, ISBN: 9780195300482 **REFERENCE BOOKS:** 1. J.D. Ryder, Networks, Lines and Fields, 2nd Edition, Pearson, 2015, ISBN 8176840254 3. K. D. Prasad, Antenna & Wave Propagation, 4th Edition, Satya Prakashan, 2009, ISBN-13: 9789351922186 4. Nathan Ida, Engineering Electromagnetics, 2nd Edition, Springer International Edition.2007, ISBN: 0387201564	
Course Outcomes	**Upon completion of the course, students will be able to**: CO 1. Explain coordinate systems, transformations, vector calculus concepts, and the basic principles of antenna radiation. CO 2. Compute electric and magnetic fields using fundamental electromagnetic laws and equations, including Gauss's Law and Maxwell's equations. CO 3. Apply transmission line concepts, impedance-matching techniques, and tools such as the Smith Chart for practical engineering problems. CO 4. Design and optimize antenna arrays by evaluating array characteristics and configurations for efficient electromagnetic radiation.	

Name of the Programme : **B.E. in Electronics and Computer Science**
Course Code : **ECS-329**
Title of the Course : **AI and its Applications**
Number of Credits : **4**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic knowledge of engineering mathematics and fundamental programming skills.	
Course Objectives:	**The course aims to provide the student with**: 1. Understanding of fundamental Artificial Intelligence concepts, including intelligent behavior, problem formulation, and classical search strategies. 2. Ability to apply heuristic and optimal search algorithms, game-tree search, and planning techniques to solve AI problems. 3. Knowledge and practical use of symbolic knowledge representation, propositional and predicate logic, and logical inference methods. 4. Exposure to core machine learning and AI techniques, including decision trees, linear models, neural networks, reinforcement learning, and modern deep-learning approaches for natural language processing.	
Contents:		**No of Hours**
UNIT- 1	**Introduction to AI:** What is intelligence? Problem Solving: Defining a problem. **State Space Search:** Breadth First Search, Depth First Search. **Heuristic Search:** Generate and Test, Simple Hill Climbing, Steepest-Ascent Hill Climbing, Best First Search, A* algorithm. **Optimal Search:** Iterative Deepening A*, Recursive Best First Search. **Game Playing:** Mini-Max Search Procedure, Alpha-Beta Pruning.	**15**
UNIT-2	**Knowledge Representation:** Representation and Mapping, Approaches to knowledge representation. **Predicate Logic:** Representing simple facts and logic, Representing instance and ISA relationship, Computable functions and predicates. **Logic and Inferences:** Formal Logic, Propositional Logic, Resolution method in Propositional Logic, and First Order Logic, Forward & Backward Chaining. **Planning:** STRIPS, Forward and Backward State Space Planning, Goal Stack Planning, Plan Space Planning.	**15**
UNIT -3	**Learning From Examples:** Forms of Learning. Learning Decision Trees, PAC learning, Linear Regression and Classification	**15**

	Deep Learning: Simple Feed forward Networks, Recurrent Neural Networks **Reinforcement Learning:** Learning from Rewards, Passive Reinforcement Learning, Active Reinforcement Learning, Applications of Reinforcement Learning	
UNIT -4	**Natural Language Processing:** Language Models, Grammar, Parsing, Complications of Real Natural Language, Augmented Grammars, Natural Language Tasks **Deep Learning For NLP:** Word Embeddings, Recurrent Neural Networks for NLP, Sequence-to-Sequence Models, The Transformer Architecture, Pre-training and Transfer Learning	**15**
Pedagogy:	Interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills	
References/ Readings:	**TEXTBOOKS:** 1. Elaine Rich, Kevin Knight, Artificial Intelligence,3rd Edition, TMH, 2017, ISBN:9780074624755 2. Stuart Russell, Peter Norvig, Artificial Intelligence: A Modern Approach,4th Edition, Pearson, 2022, ISBN-13: 978-9356063570 **REFERENCE BOOKS:** 1. Nils J. Nillson, Artificial Intelligence: A new Synthesis, Standard Edition, Morgan Kauffman, (Harcourt Asia), 2002, ISBN-13: 978-1558604674 2. Patrick Winston, Artificial Intelligence, 3rd Edition, Pearson Education,1992, ISBN-10: 0201533774	
Course Outcomes:	**After going through this course, the students will be able to:** CO 1. Represent knowledge using propositional and predicate logic and perform reasoning through resolution, forward chaining, backward chaining, and planning techniques. CO 2. Apply classical search, heuristic search, and optimal search techniques to solve AI problem-solving tasks. CO 3. Implement machine learning models—decision trees, linear regression/classification, neural networks—and apply reinforcement learning methods in appropriate contexts. CO 4. Apply NLP techniques such as language modelling, parsing, and grammar-based processing, and develop deep-learning models using embeddings, RNNs, Seq2Seq and Transformers for language understanding tasks.	