COURSE FILE

DIGITAL ELECTRONICS (ESC-301)

ECE- 3RD SEMESTER

ACADEMIC YEAR (2024-25)

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CONTENTS

VISION OF THE INSTITUTE

To create a world - class institution.

MISSION OF THE INSTITUTE

To deliver exceptional value to students, industry & society.

VISION OF THE DEPARTMENT

To become a world class Department of Computer Science with demonstrated excellence in teaching, research, and innovation.

MISSION OF THE DEPARTMENT

1. To impart high quality instruction in computer science, equipping students with fundamental knowledge and skills to address real world challenges in emerging domains.
2. To integrate academics, research, innovation, and entrepreneurship to create significant values for all stakeholders.
3. To develop meaningful linkages with world class organizations to constantly enhance capacity and capability.

SYLLABUS

Course Code	Course Name	Course Type	Cd	L	T	P	Marks		
							Sessional	Final Exam	Total
ESC-301	Digital Electronics	Core	4	3	1	0	50	100	150
Faculty Details	sarabdeep.ece@mietjammu.in								

Section-A

Unit 1: Data and number systems: Binary, Octal and Hexadecimal representation and their conversions; BCD, ASCII, EBDIC, Gray codes, Excess-3 and their conversions; Signed and unsigned binary number representation with 1's and 2's complement methods, Binary arithmetic, Overview of Boolean algebra, Simplification of logic variable using K-map method, Quine McCluskey method.

(12 Hrs)

Unit 2: Combinational circuits: Encoder, Decoder, Comparator, Binary Adder-Subtractor, Parallel Adder, Multiplexer, De-Multiplexer, Code converters and Parity Generator and checker, Memory Systems: RAM, ROM, EPROM, EEROM, Design of combinational circuits-using ROM, Programming logic devices and gate arrays (PLAs and PLDs).

(12 Hrs)

Unit 3: Sequential Circuits: Basic memory elements, S-R, J-K (master-slave), D and T Flip-Flops, their conversions with excitation table. Various types of Registers, Synchronous and Asynchronous Counters and their design. State Machine Design, State machine as a sequential controller, Moore and Mealy state machines.

(12 Hrs)

Section-B

Unit 4: Analog and Digital Converters: Different types of A/D (flash, successive approximation, delta encoded) and D/A(R-2RLadderandbinaryweighted) conversion techniques.

(6 Hrs)

Unit 5: Logic Families: TTL, ECL, MOS and CMOS, their operation and specifications.

(4 Hrs)

Text Books

S.No.	Name of the Books	Author	Publisher Name	Edition (Pub. yr.)
1	Modern Digital Electronics	R.P. Jain	McGraw-Hill	4th (2010)
2	Fundamentals of Digital Circuits	Anand Kumar	PHI	4th (2016)
3	Digital Design	M. Morris Mano	Pearson	3rd (2012)

Reference Books

S.No.	Name of the Books	Author	Publisher Name	Edition (Pub. Yr.)
1	Digital Electronics	A.K. Maini	Wiley India	1st (2007)
2	Digital Electronics	Kharate	Oxford	1st (2012)

COURSE OUTCOMES

At the end of the course the student will be able to:	
CO1	Understand and examine various number systems to be used in digital design.
CO2	Minimize the expressions using Karnaugh map method and implement them using logic gates.
CO3	Design and analyze various combinational and sequential circuits.
CO4	Understand and analyze various analog and digital converters.
CO5	Formulate problems and simplify with state minimizing techniques.

CO-PO AND CO-PSO MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	-	2	-	-	-	-	3	-	-	-	2	2
2	1	-	2	-	2	-	-	-	2	-	-	-	1	1
3	1	-	-	2	2	2	1	-	2	-	-	-	3	2
4	2	1	-	2	2	-	-	-	-	-	-	1	2	2
5	1	2	-	-	2	-	-	-	3	-	-	1	2	1

COURSE PLAN

Unit-I Data and Number Systems		
S.No	**Topics**	**Recommended Books**
1	Binary numbers, Number –Base Conversions Arithmetic operations using Number system	Book 1, Ch.1
2	Data Representation -fixed and floating, Complements (1's and 2's)	Book 1, Ch.1
3	Binary codes –weighted/non-weighted codes, BCD codes, Excess 3 code, grey codes, Conversion between codes	Book 2, Ch.2
4	Code convertors Codes for error detection and correction (Hamming code)	Book 3, Ch.1
5	Karnaugh Map (upto five variables), Quine Mc-clusky Methods	Book 1, Ch.3
Unit-II Combinational Circuits		
6	Combinational Logic design -Half and Full adders, Half and full Subtractor	Book 2, Ch.3
7	BCD Adder, Comparators	Book 2, Ch.2
8	Decoders, Encoders, Multiplexers, De-Multiplexers	Book 3, Ch.4
9	Programmed logic devices–Read only memory	Book 2, Ch.2
10	Programmable Read only Memories (PROM)	Book 1, Ch.1
11	Programmable Logic Arrays (PLA) and Programmable Array Logic (PAL)	Book 2, Ch.2
Unit- III Sequential Circuits		
12	Latches and Flip-flops, conversion between flip flops	Book 2, Ch.1
13	Shift Registers	Book 1, Ch.6
14	Synchronous and Asynchronous counters	Book 3, Ch.1
15	State Machine Design and sequential controller.	Book 1, Ch.1
16	Moore and Mealy state machines	Book 2, Ch.1
Unit-IV Analog and Digital Converters		
17	Different types of A/D (flash, successive approximation)	Book 1, Ch.4
18	Different types of A/D (delta encoded)	Book 3, Ch.1
19	Different types of D/A(R-2RLadder)	Book 2, Ch.2
20	Different types of D/A (Binary weighted)	Book 1, Ch.1
Unit-V Logic Families		
21	TTL and ECL	Book 1, Ch.1
22	MOS and CMOS.	Book 3, Ch.6
23	Operation and specifications.	Book 3, Ch.7

COURSE ASSESSMENT PLAN

Assessment		Weightage in Marks	CO Mapping
Internal	Mid Semester Examination	20	CO1, CO2, CO3
	Assignment	20	CO4, CO5
	Attendance	10	-
External	Final Examination	100	All COs

QUESTION BANK

S. No.	Question	CO	Blooms Level
	Unit 1		
1	What is the base of the binary number system?	CO 1	1
2	Write the purpose of Gray code in digital communication?		1
3	Explain the process of converting a decimal number to binary.		2
4	How does the Hamming code detect and correct errors in data transmission?		2
5	Perform the conversion of the hexadecimal number "1A3" to its binary equivalent.		3
6	Apply the rules of BCD (Binary-Coded Decimal) to represent the decimal number 25.		3
7	Analyze the advantages and disadvantages of using excess-3 code over other binary-coded decimal (BCD) representations.		4
8	Compare and contrast the features of Gray code and binary code in terms of error detection.		4
9	Evaluate the efficiency of Karnaugh Maps (K-maps) in simplifying Boolean expressions compared to other methods.		5
10	Assess the impact of using a larger word size in a computer system on data representation and storage.		5
	Unit 2		
1	What is the basic function of a combinational circuit?	CO 2	1
2	Write the key difference between combinational and sequential circuits?		1
3	Explain how the XOR gate works in a combinational circuit.		2
4	How does a multiplexer differ from a demultiplexer, and what are their individual functions?		2
5	Given a truth table, design a 4-to-1 multiplexer using basic logic gates.		3
6	Apply the concept of Boolean algebra to simplify the expression ABC + A'BC + AB'C.		3
7	Compare and contrast half-adders and full-adders in terms of functionality and circuit structure.		4
8	Evaluate the impact of increasing the number of inputs on the complexity of a combinational circuit.		4
9	Critically assess the advantages and disadvantages of using a parallel adder versus a serial adder.		5
10	Analyze the implications of adding more stages to a ripple carry adder in terms of propagation delay and circuit speed.		5
	Unit 3		
1	What is the primary characteristic that distinguishes sequential circuits from combinational circuits?		1

2	Write the purpose of a flip-flop in digital circuits?	CO 3	1
3	Explain the concept of clocking in sequential circuits and its role in synchronization.		2
4	How does a shift register differ from a counter, and what are their respective applications?		2
5	Design a basic 2-bit synchronous counter using JK flip-flops.		3
6	Apply the concept of clock edge-triggered flip-flops to create a simple sequential circuit.		3
7	Compare and contrast synchronous and asynchronous counters in terms of performance and complexity.		4
8	Analyze the potential issues associated with metastability in sequential circuits and suggest possible solutions.		4
9	Assess the advantages and disadvantages of using a synchronous design approach in sequential circuit design.		5
10	Evaluate the impact of increasing the number of flip-flops in a shift register on the storage capacity and speed of the circuit.		5
Unit 4			
1	What is the primary function of an analog-to-digital converter (ADC)?	CO 4	1
2	Write the basic principle behind pulse code modulation (PCM) in digital signal processing?		1
3	Explain the difference between quantization and sampling in the context of analog-to-digital conversion.		2
4	How does the resolution of an ADC impact its ability to accurately represent analog signals?		2
5	Design a simple voltage-to-frequency converter circuit using an operational amplifier.		3
6	Apply the Nyquist theorem to determine the minimum sampling rate required for a given analog signal bandwidth.		3
7	Compare and contrast successive approximation and dual-slope methods in analog-to-digital conversion.		4
8	Analyze the impact of noise on the accuracy of analog-to-digital conversion and propose mitigation techniques.		4
9	Evaluate the trade-offs between speed and accuracy in flash ADCs versus SAR ADCs.		5
10	Assess the advantages and disadvantages of using a sigma-delta ADC for low-frequency signal acquisition.		5
Unit 5			
1	What is the primary function of a logic gate in digital electronics?	CO 5	1
2	Write the significance of the term "fan-out" in the context of digital ICs?		1
3	Explain the difference between TTL (Transistor-Transistor Logic) and CMOS (Complementary Metal-Oxide-Semiconductor) logic families.		2
4	How does the propagation delay in digital ICs affect the overall speed of a circuit?		2
5	Design a 4-input AND gate circuit using CMOS logic.		3
6	Apply the concept of open-drain outputs in digital ICs and explain their applications.		3
7	Compare and contrast the characteristics of ECL (Emitter-Coupled Logic) and TTL logic families.		4
8	Analyze the trade-offs between power consumption and speed in CMOS and TTL technologies.		4
9	Evaluate the advantages and disadvantages of using CMOS logic in terms of		5

	power efficiency and noise immunity.		
10	Assess the impact of temperature variations on the performance of ECL logic compared to other logic families.		5

SAMPLE ASSIGNMENT

Course Name - Digital Electronics
Course Code - ESC-301
Maximum Marks - 20
Due Date:

Question Number	Course Outcomes	Blooms' Level	Maximum Marks	Marks Obtained
Q1	CO4	5	10	
Q2	CO5	4	10	
Total Marks			20	
Faculty Signature: Email:				

Assignment Objectives:

The objective of this assignment is to deepen the understanding of digital electronics by exploring the concepts of finite state machines and A to D converters.

Assignment Instructions:

1. Group A: 2022A1R001 to 2022A1R006
2. Assessment Rubrics: The evaluation will be done as per the rubrics.
3. Submission Method: All the students will submit their individual hard copy of assignment and upload the same on Camu LMS on or before the Due date. No late submissions will be considered for the evaluation.

Guidelines for Each Question:

Clearly document your design process, including circuit diagrams, truth tables, and state diagrams. Ensure clarity and coherence in your documentation and presentation.

Q. No.	Question	BL	CO	Marks	Total Marks
1	Design an R-2R ladder type 5-bit input (10101). a. Explain the equivalent circuit with a suitable diagram. b. Calculate the output voltage, if logic level '0' is 0V and logic level '1' is 10 V.	5	4	10	10
2	Design a circuit that takes as input a serial bit stream and outputs a '1' whenever the sequence "1001" occurs. Overlaps must also be considered in the design. a. Construct a finite state machine for a given problem statement. b. Implement the FSM using digital logic gates and flip-flops. c. Demonstrate the ability to represent states, transitions, and outputs in a state diagram and truth table	5	5	10	10

SAMPLE MID SEMESTER EXAMINATION

Course Name - Digital Electronics
Course Code - ESC-301
Maximum Marks - 20
Time duration - 90 Mins

Instructions

- Question 1, 2 and 4 are mandatory.
- Each question carries 4 marks.

Q.No.	Statement	Bloom's Level	CO Mapping
1	Design a 3-to-8 decoder using basic logic gates (AND, OR, NOT). Provide the truth table and logic diagram for the decoder.	Create	CO1
2	State De Morgan's theorem in Boolean algebra. Explain with an example.	Remember	CO2
3a	Define the complement of a Boolean function. Give an example and its truth table.	Understand	CO1
3b	Discuss the TTL logic family and show the NAND gate realization using the same.	Understand	CO1
4	Explain Gray to Binary code converter with gate level diagram.	Understand	CO2
5a	Given a Boolean expression F = A'B + AB' + ABC, minimize the expression using Boolean algebra laws. Present the minimized form and the original expression's truth table.	Analyse	CO3
5b	Consider a 4-input multiplexer. Write the Boolean expression for the output based on the input selection. If the inputs are A, B, C, and D, and the selector inputs are S0 and S1, provide the truth table for the 4-input multiplexer.	Analyse	CO3

ANNEXURE A

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Successfully apply fundamental domain knowledge in an innovative manner to solve complex problems.
2. Build successful careers in diverse domains.
3. Demonstrate professional growth and development in their chosen field and/or progress towards an advanced degree.
4. Build reputation for excellence, leadership and ethics.

PROGRAMME OUTCOMES(POs)

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal and environmental considerations.
4. Conduct investigations of complex problems: Use research-based knowledge and research methods, including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.
5. Modern tool usage: Select/Create and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modelling to complex engineering activities, taking comprehensive cognizance of their limitations.
6. The engineer and society: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the relevant scientific and/or engineering practices.
9. Individual and teamwork: Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.
10. Communication: Communicate effectively on complex engineering activities with the engineering community and with the society-at-large, such as being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.
11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work as a member and leader in a team to manage projects and in multidisciplinary environments.
12. Life-long learning: Recognize the need for and above have the preparation and ability to engage in independent and life-long learning in the broadcast context of technological changes.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

1. Demonstrate competence in designing, implementing and testing an electronics-based system, solving a real-world problem, by utilizing advanced technologies, platforms and tools.
2. Demonstrate fundamental knowledge in digital electronics, communication/ networking, embedded systems, automation, semi-conductor technology besides other sub domains in vogue.

ANNEXURE B

BLOOM'S TAXONOMY

Bloom's Taxonomy is a hierarchical framework used to classify educational objectives and learning outcomes. Each level of Bloom's Taxonomy represents a progressively higher level of cognitive complexity and sophistication. Educators use this framework to design curriculum, assess learning objectives, and create activities that promote higher-order thinking skills. By targeting different levels of Bloom's Taxonomy, educators can ensure a balanced approach to teaching and learning that fosters deep understanding and critical thinking across various subjects and disciplines.

S.No	Level of Learning	Characteristics of Learning	Verbs in Questions or Learning Outcomes
1.	Remembering	This level involves recalling facts, basic concepts, or specific information without necessarily understanding or interpreting it.	List, Identify, Outline
2.	Understanding	At this level, students demonstrate comprehension and grasp of the meaning of information. They can explain ideas or concepts in their own words, interpret data, and summarize information.	Explain, Describe, Interpret, Distinguish
3.	Applying	Students can use acquired knowledge in new situations or contexts. They can apply concepts, principles, or procedures in a different way or to solve problems.	Apply, Calculate, Solve
4.	Analyzing	This level involves breaking down information into its constituent parts and examining relationships between them. Students can identify patterns, organize information, and make connections between ideas.	Classify, Derive, Explain
5.	Evaluating	At this level, students can make judgments about the value or quality of ideas, theories, or solutions based on criteria and standards. They can assess the strengths and weaknesses of arguments, methods, or designs.	Determine, Optimize, Evaluate
6.	Creating	The highest level of Bloom's Taxonomy involves generating new ideas, products, or ways of thinking. Students can design, compose, or invent based on existing knowledge and skills, demonstrating creativity and originality.	Formulate, Design, Create

ANNEXURE C

ASSIGNMENT GUIDELINES

1. Title Page: Use the Standardized Front Page shared by the Department.
2. Font and Spacing: Use a Times New Roman in 12-point size. 1.5 line spacing in the entire document, including the title page, headings, and references.
1. Margins: Set 1-inch (2.54 cm) margins on all sides of the paper.
2. Header: Include a header as Assignment and Course Code in the top right corner of each page (except the title page).
3. Title: Center the title of your assignment at the top of the first page. It should be bold and in title case (capitalize major words).
4. Headings: Use headings and subheadings to organize your content. Typically, use bold for main headings (e.g., "Introduction") and italics for subheadings (e.g., "Methods").
5. Page Numbers: Page numbers should be placed in the footer of each page, starting from the second page (the title page is page 1).
6. Citations and References: Use a consistent APA citation style to cite references.
7. Pagination and Length: The minimum length of the assignment should be 2000 words excluding the references.
8. Figures and Tables: If you include figures or tables, provide clear labels and captions.
9. Figure number should be placed below the Figure as Figure,1 and for the tables, the table number must be mentioned above the table as Table I.
10. Appendices (if needed): Include appendices for supplementary materials, such as charts, graphs, or lengthy data tables.
11. Submission Format: Submit your assignment in the soft copy format as PDF and upload it on CAMU as per the submission deadline. Please ensure that the assignment is renamed as Roll No.
12. Proofreading and Editing: Carefully proofread and edit your assignment for clarity, grammar, and spelling errors before submission.
13. Plagiarism must be below 15 percent for the assignment submitted.

ASSIGNMENT RUBRICS

Parameters	Criteria					Marks Distribution
	1	2	3	4	5	
Writing Skills **a) Content**	The content was not relevant to the given task	The content was minimally relevant to the given task	The content was generally relevant to the given task	The content was relevant to the given task	The content was very relevant to the given task	**2**
b) Organization	The assignment is poorly organized and lacked supporting evidence	The organization of the assignment is some what organized with minimal supporting evidence	The organization of the assignment is acceptable with some supporting evidence	The organization of the assignment is well organized and supported	The assignment is very well organized and supported	**2**
c) Grammar-Mechanics-Usage- Spelling	Too many grammatical errors	Numerous grammatical errors	Several grammatical errors	Few grammatical errors	No grammatical errors	**1**
Knowledge Skills	Student does not demonstrate the subject knowledge	Student demonstrates some grasp of the subject knowledge	Student demonstrates moderate level of the subject knowledge	Student demonstrates sufficient level of the subject knowledge	Student demonstrates sound subject knowledge	**5**
Overall Presentation/Viva	Unable to answer questions, not prepared and confidence at all	Able to answer questions but not prepared and confidence	Presentation is acceptable but there are some areas that could be improved. / Able to answer questions but with little preparation and confidence	Presentation is of good quality, with a clear effort to present the work professionally and effectively. / Able to answer questions well and slightly confidence and well prepared	Presentation (including code structure, comments, user interface, and documentation) is of exceptionally high quality. / Able to answer questions very well and confidently. Very well prepared	**10**

ANNEXURE D

ATTENDANCE GUIDELINES

S.No	Attendance Percentage	Marks to be Allotted
1	Above 90%	100 %
2	Above 85% - 90%	80 %
3	75% -85%	60%
4	Below 75%	0