AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH (AIUB)
Faculty of Engineering
Department of EEE and CoE
Undergraduate Program

COURSE PLAN

FALL 2021-2022 SEMESTER

I. Course Core and Title

EEE 3101: Digital Logic and Circuits

II. Credit

3 credit hours (3 hours of theory per week)

III. Nature

Core Course for EEE

IV. Prerequisite

EEE 2103: Electronic Devices

V. Mission of Faculty of Engineering: To develop engineers with highest level of commitment toward the betterment of the society by applying science and technology
To nurture young leaders with perspectives and ethics
To create and disseminate state of the art knowledge and technical skills with problem solving attitude for a sustainable society

VI. Vision of Faculty of Engineering: The Faculty of Engineering will endeavor to nurture young engineers for innovation and creativity dedicated to problem solving and lifelong learning for research, entrepreneurship, and professionalism with respective communities.

VII - Course Description:

This is core course of Electrical and Electronic Engineering & Computer Engineering program that presents basic tools for the design of digital circuits. It serves as a building block in many disciplines that utilize data of digital nature like digital control, data communication, digital computers etc.

This course is designed to:

Manipulate Boolean algebraic structures, Implement the Boolean Functions using NAND and NOR gates, Simplify the Boolean expressions using Karnaugh Map, Analyze and design various combinational logic circuits, Study of Storage Elements: Introduction to the behavior and structure of latches, flip-flops, and registers, Understand the importance of state diagram representation of sequential circuits, Study Sequential Circuits: Analyze and design clocked sequential circuits, Perform Timing Analysis: Introduction to timing analysis of combinational and sequential circuits. Special characteristics of Digital logic families and their comparative discussion. Definition and Problem solving on Fan out, Noise Margin, Propagation Delay, Power Dissipation, Duty Cycle and Speed Power Product. Diode Logic Gates. Basic Diode Transistor Logic Gates: RTL, DTL, Modified DTL and HTL with operational detail.

MOS and CMOS Logic with operational detail. Basic memory units and operations. Memory system: RAM Family. Memory System: ROM Family. Memory System: Flash Memory, Magnetic storage, USB Flash Drive, SSD hard drive. DSP basics: Sample and Hold circuits. Digital to Analog Conversion with application. Analog to Digital Conversion with application. Operation and Mathematical operation of 555 integrated timer circuit: Monostable, Astable multi-vibrator. Introduction to Programmable Logic Devices (PLDs): Advantages & disadvantages over discrete logic gates, Implementation of digital circuits using PLDs (using PAL and PLA).

VIII – Course Outcomes (CO) Matrix:

By the end of this course, students should be able to –

COs	Details	Level of Domain			K	P	A	Delivery methods and activities	Assessed Program Outcomes (PO)#	Assessment
		C	P	A						
CO1	Remember characteristics of various logic gates, techniques of simplification of expressions using Boolean algebra/ k-map, techniques of drawing logic gate circuits (both gate and transistor level), and special characteristics of logic families.	1							N/A	
CO2	Understand the applications of Boolean algebra simplification and apply appropriate techniques to design digital logic circuits (Combinational Logic Circuits like, adder, 2's complement, magnitude comparator, encoder/ decoder, multiplexer/ demultiplexer) at gate level and transistor level (using RTL, DTL, TTL, CMOS), negative temperature co-efficient for MOSFET	2							N/A	10+10 Quiz 3, Q4
CO3	Formulate solutions of a complex engineering problem with conflicting requirements by applying information, concepts and procedures in engineering fundamentals of digital logic and circuits at gate and transistor level.	**3**			**3**	**P1 P2 P6**			**P.a.3.C3**	**In Class Assignment**
CO4	Remember Logic Gate Diagrams, Truth-Table & Timing Diagrams for Latches & Flip-Flops, techniques of drawing timing diagrams of sequential logic circuits, concept of memory and memory devices, sampling, filtering and quantization.	1							N/A	10 Final Q2
CO5	Understand applications of Flip-flops, methods of conversion of digital signals	2							N/A	

	to analog signals and vice-versa and timer operation.									

Level of Domain (C: Cognitive; P: Psychomotor; A: Affective)
K: Knowledge Profile; P: Range of Complex Engineering Problem Solving; A: Range of Complex Engineering Activities
** Culminating CO for PO attainment*
 # For details please check the appendix A

IX – Topics to be Covered*:

Time Frame	CO	Topics	Teaching Activities	Assessment	Evidence
Week 1	CO1	Mission & Vision of AIUB, Dept. of EEE, Digital Logic Design meaning and objectives of this course *Introduction to Integrated Circuit (IC). *Special Characteristics of digital logic families *Binary Logic, Logic gates and their truth table *Diode Logic gates Basics of semiconductor memory * Logic Gates: using RTL, Solutions of RTL Logic family mathematical problems	Lecture Tutorial	***Calculation-based question: test/project/ mid-term exam** ***Theoretical-based question: test/project/ mid-term exam**	**Quiz**
Week 2	CO1, CO2	*Logic Gates: using DTL and Modified DTL. *Problem solving on Fan of DTL gate. and Modified DTL gate *Logic Gates: using HTL *MOS and CMOS logic with operation detail. *Negative temperature co-efficient *Design CMOS logic circuits from equation	Lecture Tutorial		
Week 3	CO1	Boolean algebra, Simplification of logic function using Boolean Algebra, Implementing circuit from Boolean expressions De-Morgan's law Universal gates and Implementation of Basic Combinational Logic Circuits using Universal Gates only	Lecture Tutorial		**Quiz**
Week 4	CO2	Simplifying Boolean Expression using algebraic manipulation Boolean expression in Sum of Product (SOP) and Product of Sum (POS) form, Canonical forms	Lecture Tutorial		

		Standardization of SOP/POS expressions and conversions between them Simplifying Boolean Expressions using K – map			
Week 5	CO1	*Adder: Half adder, Full adder, 2's complement *Magnitude Comparators *Decoders, Encoders, Priority Encoders, Cascading of Decoders, Encoders	Lecture Tutorial		**Quiz/ Assignment/Term Exam**
Week 6	CO2	*Multiplexers, De-Multiplexer Boolean Function implementation using Multiplexers, Cascading of Multiplexers, De-Multiplexers	Lecture Tutorial		
Week 7	**MID-TERM EXAM WEEK**				
Week 8	CO4	*Sequential Logic Circuit, *Different types of Flip – flop (S-R, J-K, D and T), Timing Diagram	Lecture Tutorial	***Calculation-based question: test/project/ final exam *Theoretical-based question: test/project/ final exam**	
Week 9	CO4	*Counters: Asynchronous (Cascading and Modulus Counter) and Synchronous (Cascading) [State Diagram, Table, Equation] *Designing Irregular Counters using State Diagram and State Equation	Lecture Tutorial		
Week 10	CO5	Binary Up-Down counter [State Diagram, Table, Equation] *Shift registers: Basic Shift Register Functions, Different types of Shift Registers *Shift register Counters: Johnson counter, Ring counter	Lecture Tutorial		**Quiz**
Week 11	CO4	*Memory Systems: read, write operations *RAM family, ROM family Flash memory programming, read & erase operation. Magnetic Storage: Hard Disk Drive (HDD), SSD R-L transient: Storage cycle; Related Problems.	Lecture Tutorial		
Week 12	CO4, CO5	*Operation of 555 integrated timer circuit: Monostable, Astablemultivibrator *Introduction to Programmable Logic Devices (PLDs): Advantages and disadvantages of PLDs over discreet logic gates. *Classification of PLDs	Lecture Tutorial		**In Class Assignment**

Week 13	CO3, CO4, CO5	*Designing of combinational logic circuits using different types of PLD (PAL, PLA) * Digital Signal Processing Basics, Sample and Hold Circuits *Different types of A/D Converter with application *Different types D/A converter with application. **Special In-Class Assignment for assessing P.a.3.C3**	Lecture Tutorial		
Week 14	**FINAL-TERM EXAM WEEK**				

* The faculty reserves the right to change, amend, add or delete any of the contents.

X – Course Requirement:

At least **80% class attendance** is necessary to sit for the exam. If there is any assignment given to the students, they have to submit it before the deadline decided by the course teacher.

XI – Evaluation Grading System:

The evaluation system will be strictly followed as par the AIUB grading policy. The following grading system will be strictly followed in this class.

Marking system For Theory Classes (Midterm)	
Attendance	10%
Midterm: Assignment (Not OBE)	10%
Quiz (10 mcq) (best 2 out of 3)	40%
Midterm: MCQ 20%+ Written20%	40%
Total	100%

Marking system For Theory Classes (Final term)	
Attendance	10%
Final term: OBE assessed assignment	30%
Quiz (10 mcq) (best 1out of 2)	10%
Final Term: MCQ 15%+ Written15%	30%
Project presentation + Viva (max. 4 members)	20%
Total	100%
Final Grade/ Grand Total	
Midterm:	40%
Final Term:	60%

Letter	**Grade Point**	**Numerical %**
A+	4.00	90-100
A	3.75	85-<90
B+	3.50	80-<85
B	3.25	75-<80
C+	3.00	70-<75
C	2.75	65-<70
D+	2.50	60-<65
D	2.25	50-<60
F	0.00	<50(Failed)

XII – COs and POs Assessment

COs Assessment Tools for Mid-Term

Assessment Tools		CO1 Marks	CO2 Marks	Marks for Grading
Attendance and Performance		Not counted for Assessment	Not counted for Assessment	10
Assignment		15	15	30
Quiz 1 [10 marks]	Count Best 2 out of 3	10	10	20
Quiz 2 [10 marks]				
Mid-Term Assessment MCQ + Written		Not Assessed	Not Assessed	40
Total		**25**	**25**	**100**

COs Assessment System for Final-Term

Assessment Tools		CO3 Marks	CO4 Marks	CO5 Marks	Marks for Grading
Attendance and Performance		Not counted for Assessment	Not counted for Assessment	Not counted for Assessment	10
Special In-Class Activity for assessing **P.a.3.C3** in any week of final term.		30	Not counted for Assessment	Not counted for Assessment	30
Quiz 1 [10 marks]	Count Best 2 out of 4	Not counted for Assessment	Not counted for Assessment	Not counted for Assessment	20
Quiz 2 [10 marks]		Not counted for Assessment	Not counted for Assessment	Not counted for Assessment	
Final Term Assessment Presentation + VIVA		Not counted for Assessment	20	20	40
Total		**30**	**20**	**20**	**100**

Mid-Term:

CO1 Marks: 25

CO2 Marks: 25

Final Term:

CO3 Marks: 30

CO4 Marks: 20

CO5 Marks: 20

Total P.a.3.C3 Marks from midterm and final term: 30

XIII – Teaching Method

Formal lectures will provide the theoretical base for the subject as well as covering its practical application. A set of lecture notes, tutorial examples, with subsequent discussion and explanation, together with suggested reading will support and direct the students in their own personal study.

Maximum topics will be covered from the textbook. For the rest of the topics, reference books will be followed. Some Class notes will be uploaded on the web. White board will be used for most of the time.

For some cases, multimedia projector will be used for the convenience of the students.

Students must study up to the last lecture before coming to the class and it is suggested that they should go through the relevant chapter before coming to the class. Just being present in the class is not enough- students must participate in classroom discussions.

Few assignments will be given to the students based on that class to test their class performance.

XIV – Textbook/ References

Textbooks:

[1] Thomas L. Floyd, "Digital Fundamentals" 9th edition, Prentice Hall.
[2] M. Morris Mano, "Digital Logic & Computer Design" Prentice Hall.

References:

[1] Ronald J. Tocci & Neal S. Widmer, "Digital Systems" 7th edition, Prentice Hall.
[2] Digital design – Karim and Johnson
[3] Brian Holdsworth and Clive Woods, "Digital Logic Design"-Fourth Edition.
[4] Stephen Brown and Zvonko Vranesic, "Fundamentals of Digital Logic with VHDL Design with CD-ROM"
[5] William J. Dally and R. Curtis Harting, "Digital Design: A Systems Approach"
[6] Victor P. Nelson, H. Troy Nagle, Bill D. Carroll and David Irwin, "Digital Logic Circuit Analysis and Design"
[7] John P. Hayes, "Introduction to Digital Logic Design"
[8] Norman Balabanian and Bradley Carlson, "Digital Logic Design Principles"
[9] Enoch O. Hwang, "Digital Logic and Microprocessor Design with VHDL"
[10] Joseph Cavanagh, "Digital Computer Arithmetic: Design and Implementation (Computer Science)"

XV - List of Faculties Conducting Theory

1. **Mr. Dr. Md. Abdur Rahman**
2. **Mr. Nafiz Ahmed Chisty**
3. **Mr. Asif Mahfuz**
4. **Mr. Kawshik Shikder**
5. **Mr. Sujan Howlader**
6. **Ms. Tahseen Asma Meem**
7. **Mr. Abir Ahmed**
8. **Mr. Md. Shahariar Parvez**

XVI – Verification:

Prepared by: Md. Shahariar Parvez Lecturer Course Coordinator Date: ……	Checked and certified by: Nafiz Ahmed Chisty Head In-Charge, Dept. of EEE, Faculty of Engineering Date:	Approved by: Prof. Dr. A B M Siddique Hossain Dean, Faculty of Engineering Date: .....
	Moderated by: …….. Date: ……	Moderated by: …….. Date: ……

Appendix A

Table 1: Knowledge Profile (according to BAETE Manual 2nd Edition)

Attribute	
K1	A systematic, theory-based understanding of the natural sciences applicable to the discipline
K2	Conceptually based mathematics, numerical analysis, statistics and the formal aspects of computer and information science to support analysis and modeling applicable to the discipline
K3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline
K4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline
K5	Knowledge that supports engineering design in a practice area
K6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline
K7	Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the engineer's professional responsibility to public safety; the impacts of engineering activity; economic, social, cultural, environmental and sustainability
K8	Engagement with selected knowledge in the research literature of the discipline

Table 2: Range of Complex Engineering Problem Solving (according to BAETE Manual 2nd Edition)

Attribute	**Complex Engineering Problems** have characteristic P1 and some or all of P2 to P7:
Depth of knowledge required	P1: Cannot be resolved without in-depth engineering knowledge at the level of one or more of K3, K4, K5, K6 or K8

	which allows a fundamentals-based, first principles analytical approach
Range of conflicting requirements	P2: Involve wide-ranging or conflicting technical, engineering and other issues
Depth of analysis required	P3: Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models
Familiarity of issues	P4: Involve infrequently encountered issues
Extent of applicable codes	P5: Are outside problems encompassed by standards and codes of practice for professional engineering
Extent of stakeholder involvement and conflicting requirements	P6: Involve diverse groups of stakeholders with widely varying needs
Interdependence	P7: Are high level problems including many component parts or sub-problems

Table 3: Range of Complex Engineering Activities (according to BAETE Manual 2nd Edition)

Attribute	**Complex activities** means (engineering) activities or projects that have some or all of the following characteristics:
Range of resources	A1: Involve the use of diverse resources (and for this purpose resources include people, money, equipment, materials, information and technologies)
Level of interaction	A2: Require resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues
Innovation	A3: Involve creative use of engineering principles and researchbased knowledge in novel ways
Consequences for society and the environment	A4: Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation
Familiarity	A5: Can extend beyond previous experiences by applying principles-based approaches

Program Outcomes (according to BAETE Manual 2nd Edition)

PO (a): Engineering Knowledge

Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization as specified in KP1 to KP4 respectively to the solution of complex engineering problems

Indicators ID	Indicators Definition	Domain	KP	CP	CA
P.a.1.C3	Apply information and concepts in *natural science* with the familiarity of issues.	Cognitive Level 3 (Applying)	K1		
P.a.2.C3	Apply information and concepts of *mathematics* to solve complex engineering problems with a range of conflicting requirements.	Cognitive Level 3 (Applying)	K2	CP1, CP2	
P.a.3.C3	Apply information and concepts in *engineering fundamentals* with the familiarity of issues.	Cognitive Level 3 (Applying)	K3		

P.a.4.C3	Apply information and concepts in *specialized engineering sciences* with the in-depth of analysis of a complex engineering problem.	Cognitive Level 3 (Applying)	K4	CP1, CP3	

PO (b): Problem Analysis

Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences. (K1 to K4).

Indicators ID	Indicators Definition	Domain	KP	CP	CA
P.b.1.C4	Identify and relate first principles of mathematics, natural sciences and engineering sciences to solve complex engineering problems.	Cognitive Level 4 (Analyzing)	K1, K2, K3	CP1, CP6	
P.b.2.C4	Formulate solutions, procedures, and methods to solve complex engineering problems	Cognitive Level 4 (Analyzing))		CP1, CP4	
P.b.3.C4	Analyze and solves complex engineering problems reaching substantiated conclusion	Cognitive Level 4 (Analyzing)	K4	CP1, CP2	
P.b.4.C5	Research literature and Critically evaluates the validity and accuracy of existing solution methods using specialized engineering knowledge.	Cognitive Level 5 (Evaluating)	K4		

PO (c): Design/ development of solutions

Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations. (K5).

Indicators ID	Indicators Definition	Domain	KP	CP	CA
P.c.1.C2	Identify the different components or processes of complex engineering problems.	Cognitive Level 2 (Understanding)		CP1, CP7	
P.c.2.C3	Develop solution for different components of complex engineering problem.	Cognitive Level 3 (Applying)		CP1, CP7	
P.c.3.C4	Develop probable solutions that meet specified needs with appropriate consideration for public health and safety, culture, societal and environmental considerations.	Cognitive Level 4 (Analyzing)	K5		

PO (d): Investigation

Conduct investigations of complex problems using research-based knowledge (K8) and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.

Indicators ID	Indicators Definition	Domain	KP	CP	CA
P.d.1.P3	Design Experiment to test complex engineering problem for certain constrains through appropriate research.	Psychomotor Level 3 (Precision)	K8	CP1, CP2	

P.d.2.C4	Analysis and Interpretation of collected data to provide valid conclusion acknowledging the limitations.	Cognitive Level 4 (Analyzing)			
P.d.3.C6	Develop and Synthesis of complex engineering problems using substantial engineering knowledge	Cognitive Level 6 (Creating)		CP1, CP4	

PO (e): Modern Tool Usage

Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering problems, with an understanding of the limitations. (K6).

Indicators ID	Indicators Definition	Domain	KP	CP	CA
P.e.1.C3	Select and Apply appropriate techniques to solve complex engineering problems using modern engineering tools considering the limitations.	Cognitive Level 3 (Applying)		CP1, CP2	
P.e.2.P4	Use engineering tools for prediction and modeling of complex engineering problems considering the practice in electrical and electronic engineering discipline.	Psychomotor Level 4 (Articulation)		CP1, CP5	
P.e.3.P5	Create relevant resources for complex engineering problems using modern engineering tools.	Psychomotor Level 5 (Naturalization)	K6	CP1, CP7	

PO (f): 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 professional engineering practice and solutions to complex engineering problems. (K7)

Indicators ID	Indicators Definition	Domain	KP	CP	CA
P.f.1.A3	Accepts and Recognize the role of engineering in society, health, safety, legal and culture.	Affective Level 3 (Valuing)			
P.f.2.C5	Design solution for complex engineering problem in accordance with professional practices	Cognitive Level 5 (Evaluating)	K7	CP1, CP3	

PO (g): Environment and Sustainability

Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts. (K7)

Indicators ID	Indicators Definition	Domain	KP	CP	CA
P.g.1.C5	Evaluate sustainability of complex engineering problems considering society and environment.	Cognitive Level 5 (Evaluating)	K7	CP1, CP2	

P.g.2.C5	Identify impact on society and environment for professional engineering solutions.	Cognitive Level 5 (Evaluating)	K7		

PO (h): Ethics

Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice. (K7)

Indicators ID	Indicators Definition	Domain	KP	CP	CA
P.h.1.A5	Demonstrates knowledge of ethical standards (i.e. Code of Ethics)	Affective Level 5 (Characterization)			
P.h.2.A4	Demonstrates individual responsibilities based on norms of engineering practice.	Affective Level 4 (Organization)	K7		

PO (i): Individual and Team work

Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

Indicators ID	Indicators Definition	Domain	KP	CP	CA
P.i.1.A2	Function as effective team leader/member in multi-disciplinary problems.	Affective Level 2 (Responding)			
P.i.2.A2	Displays good interpersonal skills as a member/leader.	Affective Level 2 (Responding)			
P.i.3.A5	Demonstrate individual skills in solving multi-disciplinary problems.	Affective Level 5 (Characterization)			

PO (j): Communication

Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Indicators ID	Indicators Definition	Domain	KP	CP	CA
P.j.1.A2	Demonstrates an ability to effectively give and respond to clear instructions.	Affective Level 2 (Responding)			CA1, CA3
P.j.2.P3	Produces written engineering reports by applying principle based approaches and design documentation on complex engineering activities for different stake holders.	Psychomotor Level 3 (Precision)			CA1, CA5
P.j.3.A2	Perform effective oral presentation on complex engineering activities.	Affective Level 2 (Responding)			CA2, CA4

PO (k): Project Management and Finance

Demonstrate knowledge and understanding of engineering management principles and economic decision making and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Indicators ID	Indicators Definition	Domain	KP	CP	CA
P.k.1.P4	Apply engineering management principles and economic decision making to solve engineering projects as a team.	Psychomotor Level 4 (Articulation)			
P.k.2.P4	Manage multi-disciplinary projects as a member/leader.	Psychomotor Level 4 (Articulation)			
P.k.3.A5	Demonstrate competency in completing individual engineering project based on relevant management principles and economic models.	Affective Level 5 (Characterization)			

PO (l): Lifelong learning

Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Indicators ID	Indicators Definition	Domain	KP	CP	CA
P.l.1.A1	Investigate and gather information on a given engineering issue.	Affective Level 1 (Receiving)			
P.l.2.A4	Seek and use resources in solving engineering problems.	Affective Level 4 (Organization)			
P.l.3.A5	Recognizing the need for continuing education and participation in professional societies and meetings.	Affective Level 5 (Characterization)			