	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Computer Science and Engineering**	Year of Regulation	**2019-20**
Department	**Computer Science and Engineering**	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
CS 325	**Modern Digital Arithmetic**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To teach different data representation used in a digital computer and device.		CO1	Identify, understand and apply different number systems and codes.
			CO2	Understand and use the advanced addition algorithms for multioperand addition/subtraction.
	To discuss different ways of hardware design for arithmetic operations.		CO3	Understand the concept of advanced multipliers and their uses in different situations.
			CO4	Understand the concept of advanced dividers and their uses in different situations.
	To introduce different techniques employed to speed up the computer and processing unit.		CO5	Understand the concept of advanced pipelining and other methods used to increase the total throughput of an arithmetic circuit.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**2**	**3**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**3**	**1**
2	CO2	**3**	**2**	**3**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**1**
3	CO3	**3**	**2**	**3**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**1**
4	CO4	**3**	**2**	**3**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**1**
5	CO5	**3**	**2**	**3**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**1**

SYLLABUS

No.	Content	Hours	COs
I	Signed numbers: Signed-Magnitude Representation, Biased Representations, Complement Representations, Two's- and 1's-Complement Numbers, Direct and Indirect Signed Arithmetic, Using Signed Positions or Signed Digits. Redundant number systems: the Carry Problem, Redundancy in Computer Arithmetic, Digit Sets and Digit-Set Conversions, Generalized Signed-Digit Numbers, Carry-Free Addition Algorithms, Conversions and Support Functions. Residue number systems: RNS Representation and Arithmetic, the RNS Moduli, Difficult RNS Arithmetic Operations, Redundant RNS Representations, Limits of Fast Arithmetic in RNS.	**08**	**CO1**
II	Fast Addition and subtraction: Simple Carry-Skip Adders, Multilevel Carry-Skip Adders, Carry-Select Adders, Conditional-Sum Adder, Hybrid Adder Designs, Optimizations in Fast Adders. Multioperand addition: Using Two-Operand Adders, Carry-Save Adders, Wallace and Dadda Trees, Parallel Counters, Generalized Parallel Counters, Adding Multiple Signed Numbers.	**08**	**CO2**
III	Fast multipliers: Radix-4 Multiplication, Modified Booth's Recoding, Using Carry-Save Adders, Radix-8 and Radix-16 Multipliers. Tree and array multipliers: Full-Tree Multipliers, Alternative Reduction Trees, Tree Multipliers for Signed Numbers, Partial-Tree Multipliers, Array Multipliers, Pipelined Tree and Array Multipliers. Variations in multipliers: Divide-and-Conquer Designs, Additive Multiply Modules, Bit-Serial Multipliers, Modular Multipliers, The Special Case of Squaring, Combined Multiply-Add Units.	**09**	**CO3**
IV	Fast Dividers: Basics of High-Radix Division, Radix-2 SRT Division, Using Carry-Save Adders, Choosing the Quotient Digits, Radix-4 SRT Division, General High-Radix Dividers. Division by convergence: General Convergence Methods, Division by Repeated Multiplications, Division by Reciprocation, Speedup of Convergence Division, Hardware Implementation, Analysis of Lookup Table Size.	**07**	**CO4**
V	High-throughput arithmetic: Pipelining of Arithmetic Functions, Clock Rate and Throughput, Parallel and Digit-Serial Pipelines, On-Line or Digit-Pipelined Arithmetic. Low-power arithmetic: The Need for Low-Power Design, Sources of Power Consumption, Reduction of Power Waste, Transformations and Trade-Offs, Some Emerging Methods	**07**	**CO5**
	Total Hours	**39**	

Essential Readings:

1. Behrooz Parhami, "Computer Arithmetic: Algorithms and Hardware Designs", 1st ed., 2000, Oxford university press.
2. Mi Lu., "Arithmetic and logic in computer systems", 1st ed., 2004, John Wiley and Sons.
3. Paul Zimmermann and Richard Brent, "Modern Computer Arithmetic", 1st ed. 2010, Cambridge university press.

Supplementary Readings:

1. Donald e. Knuth., "The art of computer programming", 2nd ed., 1985, Addison-Wesley publishing company.
2. M Ercegovac, T Lang, "Digital Arithmetic", Hardware and Programming", 1st ed., 2004, Morgan Kaufmann publishers.
3. Israel Koren, "Computer Arithmetic Algorithms", 2nd ed., 2002, A.K. Peters.