Bachelor of Technology in Computation & Mathematics

I. About Computation & Mathematics

B.Tech. in Computation & Mathematics program is one of the most versatile and interdisciplinary programs at Mahindra University. Mathematics along with the principles of computation are ubiquitous to understanding and development of almost every realm of sciences and engineering. CM graduates would find relevance in academia and industries involved in scientific computation, data analysis, and mathematical modeling. In addition, the graduates will exhibit entrepreneurial mindset and interpersonal skills along with technical knowledge for effective communication, innovation and implementation of new ideas.

II. About the Department of Mathematics

The Department of Mathematics has been playing a key role in shaping analytical mindset of the engineering graduates at Mahindra Ecole Centrale (now Ecole Centrale School of Engineering, Mahindra University). Rigorous training in fundamentals of mathematics has been a distinctive feature of Mahindra University's B.Tech. Programs. From the academic year 2020-2021, the Department of Mathematics has floated its flagship program B.Tech. in Computation & Mathematics. The teaching and research interests of the Mathematics department faculty span over diverse areas such as Fluid Mechanics, Partial Differential Equations, Mathematical Finance, Image Processing, Numerical Analysis, Delay and Fractional Differential Equations, Optimization, Algebra, Numerical Linear Algebra, Computational Fluid Dynamics. The department executes its mission with a focus on enhanced student-teacher interaction and collaboration for research.

The students will be trained in the skills necessary to solve advanced scientific problems arising in multi-disciplinary domains such as Mathematical Finance, Computational Biology, Computational Topology, Quantum Computing, Cryptography, Data Structures, Graph Algorithms, Design and Analysis of Algorithms, Theory of Computation, Computer Networks, Operating Systems, Database Management Systems among many more domains. Further the program offers many specialized courses via multiple Elective Baskets. Apart from acquiring advanced skills, students will be exposed to basic sciences and engineering concepts, design thinking, enterprise, economy, and entrepreneurship. In addition, emphasis will be given towards effective communication, personality, and soft skills development. During the second half of the program, the students will specialize in the following focus areas:

1. Data Science/Data Analytics
2. Financial Mathematics
3. Quantum computing
4. Cryptography
5. Drug Design

The selection of electives is expected to address specific interests of the students and serve to educate the student on current and future technologies while also preparing them for higher studies. The majority of the fundamental courses of Computation & Mathematics is completed by the sixth semester and is intended to form a basis for the students to tackle significant real-world problems during the final year project.

III.   Program Objectives

The Department of Mathematics offers a four-year degree program leading to B.Tech. in Computation & Mathematics. The program objectives are listed below.

1. The objective is to prepare engineering professionals with strong foundation in Computer Science and Mathematics.
2. Acknowledging the scarcity of professionals equipped with cutting edge mathematical techniques like Deep Learning, AI and ML. This program aims to correct this gap.
3. This program aims to prepare for smooth adaptation and transition to new emerging technologies of the future driven by fundamentals of mathematics.

IV.   Program Outcomes

By the end of the program, the graduates are expected to have a strong understanding of the basic principles of computation and mathematics. The specific outcomes expected of the program are listed below.

1. The graduates will be able to solve real-life problems faced by industries which require mathematical approach of solution blended with elegant computing techniques.
2. The graduates will be well prepared to pursue interdisciplinary research career encompassing scientific computation, data analysis, and mathematical modeling.
3. The graduates will exhibit entrepreneurial mindset and interpersonal skills along with technical knowledge for effective communication, innovation and implementation of new ideas.

V. Curriculum

The four-year curriculum consists of courses worth a total of around **180 credits.** The courses are broadly categorized as Mathematics and Sciences, Basic Engineering, Core Mathematics and Computer Science, Core electives and CM elective baskets, Humanities and Management, and Projects. Apart from these, French language is offered as a compulsory subject in the first year and optional for the subsequent years.

R2020 Proposed Course Curriculum Outline – Semester Wise.

		Computation & Mathematics (R-2020)					
		Semester 1 (CM 2020 Batch)					
		Course name	**L**	**T**	**P**	**Credits**	
1	MA1101	Mathematics – I	4	1	0	5	
2		Chemistry – I	2	1	0	3	
3		Introduction to Electrical Engineering	2	1	2	4	
4		Engineering Drawing	0	0	3	1.5	
5		Earth and Environmental Sciences	2	0	0	2	
6		Thermodynamics	2	1	0	3	
7		Media Project	1	0	2	1.5	
8		English and Humanities-I	1	2	2	4	
9		French Language & Culture – I	0	2	0	0	
		Total credits				**24**	
		Semester 2 (CM 2020 Batch)					
		Course name	**L**	**T**	**P**	**Credits**	
1	MA1202	Mathematics – II	3	1	0	4	
2		Physics – I	2	1	2	4	
3		Chemistry-II	2	0	2	3	
4		Electronics	2	1	2	4	
5		Introduction to Computer Science	2	1	2	4	
6		Workshop	0	0	2	0	

			L	T	P	Credits	
7		Introduction to Enterprises & Economy	2	1	0	3	
8		Professional Ethics	0	1	0	1	
9		French Language & Culture – II	0	2	0	0	
		Total credits				**23**	

Semester 3 (CM 2020 Batch)						
		Course name	**L**	**T**	**P**	**Credits**
1	MA2103	Mathematics-III (Probability and Statistics)	3	1	0	4
2		Physics-II	3	1	2	5
3	MA2104	Real Analysis	3	0	0	3
4		Data Structures	3	0	2	4
5	MA2105	Graph Algorithms	3	0	0	3
6	MA2106	Algebra	3	0	0	3
7	MA2107	Prog. Workshop (R Programming and GPU computing)	0	0	2	1
8		Learn start-up	0	0	3	1
9		Economics	3	0	0	1.5
10		French-III	0	2	0	0
		Total credits				**25.5**

Semester 4 (CM 2020 Batch)						
		Course name	**L**	**T**	**P**	**Credits**
1	MA2208	Mathematics-IV (Numerical Methods)	3	0	2	4
2	MA2209	Number theory and Cryptography	3	0	0	3
3	MA2210	Optimization Techniques	3	0	0	3
4		Theory of Computing	3	0	0	3
5	MA2211	Computer Organization	1	0	0	1
6	MA2212	Functional Analysis	3	0	0	3
7	MA2213	Stochastic Process	3	0	0	3
8		Design Thinking	1	0	2	2
9		Financial Accounting (7 weeks)	3	0	0	1.5
10	MA2214	Programming Workshop (R and MATLAB)	0	0	2	1
11		French Language & Culture – IV/Other	0	2	0	0

		Total credits				**24.5**

Semester 5 (CM 2020 Batch)

		Course	L	T	P	Credits
1	MA3115	Computational Methods for PDE	3	1	0	4
2		Operating Systems	3	0	2	4
3		Design and Analysis of Algorithms	2	1	2	4
4		Database Management Systems	3	0	2	4
5		Financial Mathematics	3	0	0	3
6		Advanced Linear Algebra	3	0	0	3
7		Prog. Workshop (Python)	0	0	2	1
8		French Language & Culture – V	0	2	0	0
9		HSS Elective-I	2	0	0	2
		Total credits				**25**

Semester 6 (CM 2020 Batch)

		Course	L	T	P	Credits
1		Mathematical Foundations for Machine Learning	3	0	2	4
2		Computer Networks	3	0	2	4
3		Elective-I (choose one elective from Mathematics basket)	3	0	0	3
4		Core-Elective – I [choose one elective] Operations Research /Measure Theory and Integration/SDE]	3	0	0	3
5		HSS-Elective-II	2	0	0	2
6		French Language & Culture – VI	0	2	0	0
7		Introduction to Professional Development	2	0	0	2
8		Project-I	0	0	3	3
		Total credits				**21**

Semester 7 (CM 2020 Batch)

		Course	L	T	P	Credits
1		Quantum Computing	3	0	0	3
2		Core-Elective – II [choose one elective] Dynamical Systems/Computational Topology/Galois Theory]	3	0	0	3

		Course	L	T	P	Credits
3		Elective-II (choose one elective from AI basket)	3	0	0	3
4		Elective-III (choose one elective from hardware basket)	3	0	0	3
5		HSS Elective-III	2	0	0	2
6		Project-II	0	0	4	4
7		French Language & Culture – VII	0	2	0	0
		Total credits				**18**
		Semester 8 (R-2020)				
		Course	**L**	**T**	**P**	**Credits**
1		Elective-IV (choose one elective from software/system basket)	3	0	0	3
2		Elective – V (choose one elective from theory basket)	3	0	0	3
3		Project –III	0	0	12	12
4		French Language & Culture – VIII	0	2	0	0
		Total credits				**18**

Total credits   **179**

R2021 Proposed Course Curriculum Outline – Semester Wise.

		Computation & Mathematics (R-2021)					
		Semester 1 (CM 2021 Batch)					
		Course name	**L**	**T**	**P**	**Credits**	
1	MA1101	Mathematics – I	4	1	0	5	
2		Chemistry – I	2	1	0	3	
3		Chemistry Lab	0	0	2	1	
4		Introduction to Electrical Engineering/Electronics	2	1	2	4	
5		Engineering Drawing	0	0	3	1.5	

		Course name	L	T	P	Credits	
6		Earth and Environmental Sciences	2	0	0	2	
7		Mechanics	2	1	0	3	
8		Media Project	1	0	2	1.5	
9		English	3	0	0	3	
10		Introduction to Entrepreneurship	0	0	3	1	
11		French Language & Culture – I	0	2	0	0.5	
		Total credits				**25.5**	
	Semester 2 (CM 2021 Batch)						
		Course name	**L**	**T**	**P**	**Credits**	
1	MA1202	Mathematics – II	3	1	0	4	
2		Physics – I	2	1	2	4	
3		Biology (1-7 weeks)/ Chemistry (8-14 weeks)	3	0	0	3 (1.5+1.5)	
4		Discrete Mathematics	2	0	0	2	
5		Introduction to Computing	2	1	2	4	
6		Workshop	0	0	2	1	
7		Entrepreneurship practice	0	0	2	1	
8		Professional Ethics	0	1	0	1	
9		French Language & Culture – II	0	2	0	0.5	
		Total credits				**20.5**	

		Semester 3 (CM 2021 Batch)					
		Course name	**L**	**T**	**P**	**Credits**	
1	MA2103	Mathematics-III (Probability and Statistics)	3	1	0	4	
2		Physics-II	3	1	2	5	
3	MA2104	Real Analysis	3	0	0	3	
4		Data Structures	3	0	2	4	
5	MA2105	Graph Algorithms	3	0	0	3	
6	MA2106	Algebra	3	0	0	3	
7	MA2107	Prog. Workshop (R Programming and GPU computing)	0	0	2	1	

8		Learn start-up	0	0	3	1
9		Economics	3	0	0	1.5
10		French-III /Other	0	2	0	0.5
		Total credits				**26**

Semester 4 (CM 2021 Batch)						
		Course name	**L**	**T**	**P**	**Credits**
1	MA2208	Mathematics-IV (Numerical Methods)	3	0	2	4
2	MA2209	Number theory and Cryptography	3	0	0	3
3	MA2210	Optimization Techniques	3	0	0	3
4		Theory of Computation	3	0	0	3
5	MA2211	Computer Organization	1	0	0	1
6	MA2212	Functional Analysis	3	0	0	3
7	MA2213	Stochastic Process	3	0	0	3
8		Design Thinking	1	0	2	2
9		Financial Accounting (7 weeks)	3	0	0	1.5
10	MA2214	Programming Workshop (R and MATLAB)	0	0	2	1
11		French Language & Culture – IV/Other	0	2	0	0.5
		Total credits				**25**

Semester 5 (CM 2021 Batch)						
		Course	**L**	**T**	**P**	**Credits**
1	MA3115	Computational Methods for PDE	3	1	0	4
2		Operating Systems	3	0	2	4
3		Design and Analysis of Algorithms	2	1	2	4
4		Database Management Systems	3	0	2	4
5		Financial Mathematics	3	0	0	3
6		Advanced Linear Algebra	3	0	0	3
7		Prog. Workshop (Python)	0	0	2	1
8		French Language & Culture – V (Optional)	0	2	0	0.5
9		HSS Elective-I	2	0	0	2
		Total credits				**25.5**

		Semester 6 (CM 2021 Batch)				
		Course	**L**	**T**	**P**	**Credits**
1		Mathematical Foundations for Machine Learning	3	0	2	4
2		Computer Networks	3	0	2	4
3		Elective-I (choose one elective from Mathematics basket)	3	0	0	3
4		Core-Elective – I [choose one elective] Operations Research /Measure Theory and Integration/SDE]	3	0	0	3
5		HSS-Elective-II	2	0	0	2
6		French Language & Culture – VI (Optional)	0	2	0	0.5
7		Introduction to Professional Development	2	0	0	2
8		Project-I	0	0	3	3
		Total credits				**21.5**

		Semester 7 (CM 2021 Batch)				
		Course	**L**	**T**	**P**	**Credits**
1		Quantum Computing	3	0	0	3
2		Core-Elective – II [choose one elective] Dynamical Systems/Computational Topology/Galois Theory]	3	0	0	3
3		Elective-II (choose one elective from AI basket)	3	0	0	3
4		Elective-III (choose one elective from hardware basket)	3	0	0	3
5		HSS Elective-III	2	0	0	2
6		Project-II	0	0	4	4
7		French Language & Culture – VII (Optional)	0	2	0	0.5
		Total credits				**18.5**

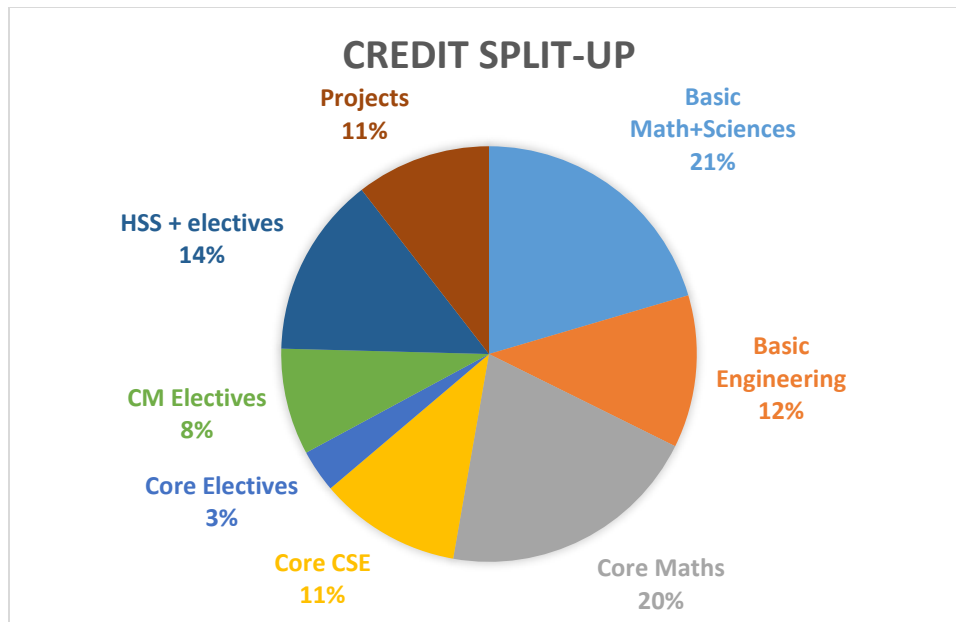|		Semester 8 (CM 2021 Batch)				
		Course	**L**	**T**	**P**	**Credits**
1		Elective-IV (choose one elective from software/system basket)	3	0	0	3
2		Elective – V (choose one elective from theory basket)	3	0	0	3

3		Project –III	0	0	12	12
4		French Language & Culture – VIII (Optional)	0	2	0	0.5
		Total credits				**18.5**

Total credits **181**

The distribution of credits into the broad categories mentioned earlier is given below. The curriculum is designed for a balanced distribution of credits between basic mathematics and sciences, basic engineering, humanities, core programs in Computation & Mathematics, electives, and projects.

S.No.	Category	Credits
1	Basic Maths+Sciences	37
2	Basic Engineering	21.5
3	Core Maths	37
4	Core CSE	20
5	Core Electives	6
6	CM Electives	15
7	HSS + electives	25.5
8	Projects	19

CREDIT SPLIT-UP

Pie chart: CREDIT SPLIT-UP
- Projects 11%
- Basic Math+Sciences 21%
- Basic Engineering 12%
- Core Maths 20%
- Core CSE 11%
- Core Electives 3%
- CM Electives 8%
- HSS + electives 14%

Core-Electives:

Core-Elective-I: Operations Research /Measure Theory and Integration/SDE
Core-Elective-II: Dynamical Systems/Computational Topology/Galois Theory

Electives:

Elective-I (Mathematics Basket): Numerical Analysis of PDE (FEM/Spectral methods/FVM)/ Meshfree Methods / Boundary Element Method and Boundary Integral Equations / PDE Based Image Processing / Topological Data Analysis / Infinite dimensional Control Theory / Bayesian Statistics / Hyperbolic Conservation Laws / Advanced Numerical Methods / DDE with MATLAB/Mathematical Methods and Calculus of Variations /Computational Fluid Dynamics/ Computational Molecular Science / Fluid Mechanics / Computational Geometry / Modelling and simulation / Time series analysis.

Elective-II (AI Basket): Principles of Artificial Intelligence / Neural Networks / Statistical

Learning Theory / Pattern Recognition / Reinforcement Learning / Deep Learning / Machine Learning / Digital Image Processing / Advanced Data Analytics / Natural Language Processing / Game theory.

Elective-III (Hardware Basket): Parallel Computer Architecture / RISC Architectures / FPGA Implementations / Secure Processor Architecture / CAD for VLSI / VLSI Design using Verilog.

Elective-IV (Software/Systems Basket): Compiler Design / System and Network Security / Distributed Algorithms / Parallel and Concurrent Programming / Program verification / Paradigms of Programming / Software Project Management / System Software / Mobile Communication and Computing / Social Computing / Performance Evaluation of Computer Networks / Wireless Sensor Networks.

Elective-V (Theory Basket): Complexity Theory / Convex Optimization / Randomized Algorithms.