

## **B.Tech and M.Tech Integrated Dual degree in Bioengineering**

### **Preamble to the programme:**

Bioengineering integrates physical, chemical, computational and life sciences with core engineering principles for the study of biology, medicine and health systems and for the application of technology to improving health and quality of life. It creates knowledge from the molecular to organ systems levels, develops materials, devices, systems, information approaches, technology management, and methods for assessment and evaluation of technology, for the biological applications. The discipline of bioengineering has evolved drastically over the past 50 years, seemingly encompassing all fields that include bioelectric phenomena, bioinformatics, biomaterials, biomechanics, bioinstrumentation, biosensors, biosignal processing, biotechnology, computational biology, medical imaging, etc. The B.Tech and M.Tech dual degree programme on Bioengineering strives to train students in the field of physical, chemical mathematical and biological sciences together with engineering principles for the development of technology aimed at providing diagnostic, therapeutic and assistive and analytical support to biological systems. The programme strives to train the students in the field of basic electrical and mechanical engineering disciplines together with principles in physical, chemical, mathematical, computational and biological sciences for inculcating knowledge enabling them in developing and deploying Bioengineering technologies in various fields. At IIT Mandi, a student needs to complete 160 credits for B.Tech in 4 years and 70 credits for M.Tech. in two years. The integrated dual degree programme in Bioengineering allows the students to go through a rigorous framework of core courses at Bachelors and Masters level and a comprehensive and detailed project and dissertation work which allows a student to graduate in 5 years with a B.Tech-M.Tech integrated dual degree earning 206 credits.

MTech allows the Bioengineers to specialise in four advanced focused areas:

- a) Biomedical Engineering aimed at gaining expertise in the areas of diagnostics, therapeutic and assistive support for healthcare applications.
- b) Agricultural Automation Technology aimed at providing automation and assistive support to agricultural practices.
- c) Environmental Science and Engineering aimed at training bioengineers to develop environment friendly processing technologies involving bio-organisms.
- d) Computational Bioengineering aimed at both developing algorithms and models to understand biological systems and processes.

The curriculum will impart training to budding students that will cater to the requirements of Bio-based industries.

### **M.Tech Specializations:**

1. Biomedical Engineering
2. Agro-Technology
3. Environmental Science and Engineering
4. Computational Bioengineering

A student can choose to take courses across specializations. In such a case, he/she will be awarded M.Tech in Bioengineering without any specialization.

**Provision of Scholarship in 5<sup>th</sup> year:** Students are eligible for HTRA in the 5<sup>th</sup> year as per existing IIT Mandi norms for integrated M.Tech. programmes.

**Duration:** 10 semesters. The degrees B.Tech in Bioengineering and M.Tech in specialized areas (Biomedical Engineering/Afro-Technology/Environmental Science and Engineering/Computational Bioengineering) will be awarded on completion of M.Tech. A student can choose to take courses across specializations. In such a case, he/she will be awarded M.Tech in Bioengineering without any specialization.

**Objectives of the programme:**

1. Assimilate knowledge of physical, mathematical and biological sciences together with engineering principles for the development of diagnostic, therapeutic and assistive technologies as well as developing algorithms and models to understand biological systems and processes.
2. Train manpower for industries dedicated to technologies applied to biological systems.
3. Develop manpower to apply engineering concepts and techniques to the investigation and exploration of biological processes.
4. Train manpower capable of solving problems related to preventive medical approaches, automation based agricultural practices, environmental friendly bioprocesses and computational techniques for understanding biological systems.

**How is this programme different?**

1. Strong engineering emphasis.
2. Freedom to choose between multiple specializations.
3. Industrial involvement in teaching courses.
4. Wide market opportunities.
5. Scope of semester exchanges with foreign universities

**Branch change policy:** The existing change of branch policy at IIT Mandi will be applicable to students enrolled in the IDD (Bioengineering) programme.

**Exit option:** There is no exit option available after 4<sup>th</sup> year for a single B.Tech degree in Bioengineering. This is in compliance with the existing practices of IIT s towards Integrated Dual Degree programmes.

**Curriculum:**

**Semester I**

Course Code	L-T-P-C	Course Name
IC110	2.5-0.5-0-3	Engineering Mathematics
IC152	3-0-3-4	Data Science I
IC160	3-0-0-3	Electrical Systems Around Us
IC160P	0-0-3-2	Electrical Systems Around Us Lab
IC140	2-0-3-4	Graphics for Design
IC101P	0-0-3-2	Reverse Engineering
HS106	3-0-0-3	English I
HS10X	1-0-0-1	Creative Understanding
<b>Total</b>	<b>22 credits</b>	

**Semester  
II**

Course Code	L-T-P-C	Course Name
IC111	2.5-0.5-0-3	Linear Algebra
IC141	2-0-0-2	Product Realization Technology
IC141P	0-0-3-2	Product Realization Technology Lab
IC161	3-0-0-3	Applied Electronics
IC161P	0-0-3-2	Applied Electronics Lab
IC252	3-0-2-4	Data Science II
HSXX1	3-0-0-3	HSS Language competence basket course
IC142	3-1-0-4	Engineering Thermodynamics
<b>Total</b>	<b>23 credits</b>	

**Semester  
III**

Course Code	L-T-P-C	Course Name
IC260	2.5-0.5-0-3	Signals and systems
IC136	3-0-0-3	Understanding Biotechnology and its applications
IC3XX	2-0-2-3	Data Science III
IC121	3-0-0-3	Mechanics of Particles and Waves
IC130	3-0-0-3	Applied Chemistry for Engineers
IC130P	0-0-3-2	Applied Chemistry Practicum
IC241	3-0-0-3	Material Science for Engineers
HSXX2	3-0-0-3	HSS basket course
<b>Total</b>	<b>23 credits</b>	

**Semester  
IV**

Course Code	L-T-P-C	Course Name
IC201P	0-0-6-4	Design Practicum
IC240	1.5-1.5-0-3	Mechanics of Rigid Bodies
IC242	2.5-0.5-0-3	Continuum mechanics
IC222P	0-0-3-2	Physics Practicum
IC221	3-0-0-3	Foundations of Electrodynamics
BEXX1	3-0-2-4	Biology-I
BEXX2	2-0-2-3	Biology-II
<b>Total</b>	<b>22 credits</b>	

**Semester  
V**

Course Code	L-T-P-C	Course Name
BEXX3	2-0-2-3	Biology-III
BEXX4	3-0-0-3	Physics and modeling of biological systems
BEXX5	2-0-2-3	Computational Biology
BEXX6	2-0-2-3	Biostatistics
BEXX7	1-0-0-1	Bioethics, and Regulatory affairs
BEXX8	3-0-0-3	Biomaterials
BEXX9	3-0-2-4	Biomechanics
<b>Total</b>	<b>20 credits</b>	

**Semester  
VI**

Course Code	L-T-P-C	Course Name
BEXX10	3-0-2-4	Biosensing and Bioinstrumentation
BEMC1	3-0-0-3	M.Tech Core-I
BEMC2	3-0-0-3	M.Tech Core-II
BEXE1	3-0-0-3	Discipline Elective-I
BEXE2	3-0-0-3	Discipline Elective-II
HSXX3	3-0-0-3	HSS basket course
FFXX1	3-0-0-3	Free Elective-I
<b>Total</b>	<b>22 credits</b>	

**Semester  
VII**

Course Code	L-T-P-C	Course Name
ITXX1	0-0-2-2	Industrial Internship
BEMC3	3-0-0-3	M.Tech Core-III
BEXE3	3-0-0-3	Discipline Elective-III
BEXE4	3-0-0-3	Discipline Elective-IV
HSXE1	3-0-0-3	HSS Elective -I
FFXX2	3-0-0-3	Free Elective-II
FFXX3	3-0-0-3	Free Elective-III
HS541	1-0-0-1	Technical Communication
<b>Total</b>	<b>21 credits</b>	

**Semester  
VIII**

Course Code	L-T-P-C	Course Name
BEXE5	3-0-0-3	Discipline Elective-V
BEXE6	3-0-0-3	Discipline Elective-VI
BEXE7	3-0-0-3	Discipline Elective-VII
FFXX4	3-0-0-3	Free Elective-IV
BEXE8	0-0-8-4	Mini Project, Term Paper and Seminar
HSXX5	2-0-0-2	HSS Elective-II
<b>Total</b>	<b>18 credits</b>	

**Semester  
IX**

Course Code	L-T-P-C	Course Name
BEXE9	0-0-34-17	M.Tech Project-I
<b>Total</b>	<b>17 credits</b>	

**Semester  
X**

Course Code	L-T-P-C	Course Name
BEXE10	0-0-38-18	M.Tech Project - 2
<b>Total</b>	<b>18 credits</b>	

**Total: 206 Credits**

## **M.Tech Core courses and Electives leading to specializations:**

### **A. Biomedical**

#### **Engineering: M.Tech Core:**

1. Anatomy and Physiology
2. Biomedical Systems (existing)
3. Analytical biotechniques (existing)

#### **Discipline Electives (any five):**

1. Medical Imaging Systems and Analysis
2. Medical Devices and Packaging
3. Biomedical Instrumentation
4. Embedded Systems (existing)
5. Neuroscience and Cognitive Science
6. Optical Microscopy
7. Next generation biomanufacturing
8. Tissue Engineering
9. Regenerative Medicine
10. Nanobiotechnology (existing)
11. Biomedical Image and Signal Analysis
12. Biosolid Mechanics
13. Biofluid mechanics

### **B. Agro-**

#### **Technology: M.Tech**

##### **Core:**

1. Precision Farming
2. IoT for agriculture
3. Agricultural biotechnology

#### **Discipline Electives (any five):**

1. Plant phenotyping
2. Machine learning for plant phenotyping
3. Plant genotyping
4. Embedded Systems
5. Bioprocess Technology
6. Post-harvest technology and management
7. Design of farm machinery/Farm mechanisation
8. Agroresidue management
9. Green House Technology
10. Storage and enhancing shelf life
11. Food processing Technologies and devices
12. Agro-cultivation technologies (Hydroponics, Aquaponics etc)
13. Technology for Agribusiness and marketing of produces
14. Irrigation technologies

### **C. Environmental Science and**

#### **Engineering:**

##### **M.Tech Core:**

1. Microbiology for environmental applications
2. Environment friendly bioprocesses
3. Environmental biotechnology practicum

**Discipline Electives (any seven):**

1. Solid waste management
2. Waste water management
3. Air pollution control techniques
4. Waste reuse and recycle
5. Toxic and hazardous waste management
6. Water quality management
7. Modeling of waste water treatment system
8. Environmental quality management

**D. Computational**

**Bioengineering: M.Tech Core:**

1. Bioinformatics
2. Analysis and Design of Algorithms
3. Biological modeling and simulation

**Discipline Electives (any five):**

1. Next generation sequencing
2. Biomedical Image and Signal Analysis
3. Computational Neuroscience
4. Deep learning
5. Pattern Recognition
6. Neuroscience and Cognitive Science
7. Modeling of bioprocess parameters
8. Transcriptomics
9. Proteomics
10. Metabolomics
11. Fluxomics
12. Computational drug discovery
13. Finite Element Methods

**E. M.Tech in Bioengineering (for candidates choosing courses across specializations)**

**M.Tech. Core courses (Any three):**

1. Biomedical Systems
2. Bioinformatics
3. Microbiology for environmental applications
4. Analytical biotechniques
5. Agricultural biotechnology

**Discipline Electives:** Any seven courses from discipline electives across all specializations.