

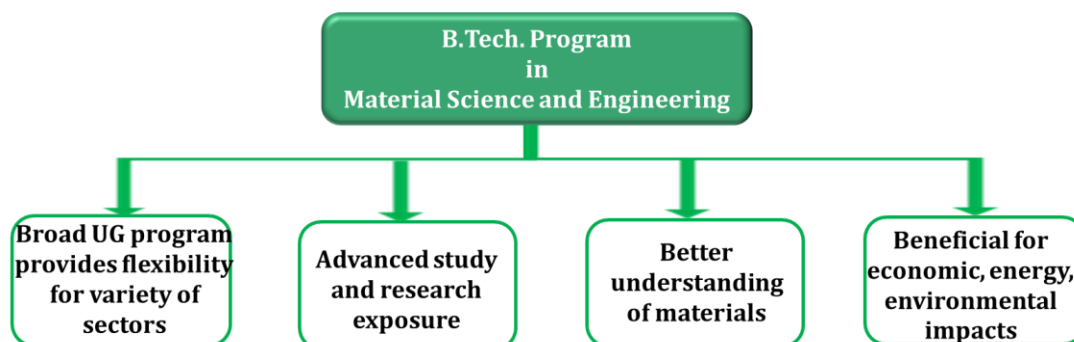
B. Tech. in Materials Science and Engineering

in

School of Mechanical and Materials Engineering (SMME)

I. Program Description:

The Bachelor of Technology (B.Tech.) in Materials Science and Engineering program aims to achieve strong foundation in Materials Science with focus on Engineering Applications by offering large number of allied engineering courses and employable skills. The idea is to develop broad B.Tech. Curriculum with a blend of science and engineering covering key elements of materials, advanced processing, additive manufacturing with hands-on training. Further the proposed curriculum will develop an understanding of the structure-properties correlation, processing, and service behavior of engineering materials, including semiconductors for electronic devices, ceramics for energy conversion and storage, and polymers for emerging biotechnologies. This understanding fosters both the development of new materials and the improvement of existing materials to optimize manufactured products and modern tools. This program will give students a strong foundation in both theoretical and practical understanding of the subject. At present scenario, student who specializes in materials science and engineering needs to study and develop solutions in the advanced emerging fields of sustainability and renewable energy, nanotechnology, quantum materials, and devices, artificial intelligence, smart materials, low-power computing, manufacturing, and productivity. We have excellent laboratories/research centers facilities for materials science and engineering at IIT Mandi. The proposed B.Tech. program will help us to bridging the gaps between the research activities and engineering education and our graduates would play a leadership role to future growth and the industry. Materials engineers also offer knowledge of materials for practical applications that serve as the cornerstone of the goods and services provided by numerous sectors. Further, the proposed B.Tech. program will promote the academic and research activities at IIT Mandi and make larger impacts in society by producing high quality engineers.



2. Credit Structure of the programme.

Division	Sub division	Credits
Institute Core	IC Compulsory	39
	IC Baskets	06
	Humanities and Social Sciences (HSS)	12
	Indian Knowledge System (IKS)	03
Discipline	Discipline Core (DC) + Reverse Engg.	44+1
	Discipline Electives (DE)	21
Electives	Free Electives (FE)	22
	Major Technical Project (MTP)	08
	Interactive Socio Technical Practicum (ISTP)	04
	TOTAL	160

The credit structure will be followed as per the existing norms of the institute. Out of 160 credits, 42 credits will be dedicated to discipline courses in which 12 credits will be reserved for six engineering labs and taught together with theory. Total of 21 credits will be assigned for discipline electives wherein few optional baskets will be introduced for promoting B.Tech. Specialization for 15 credits. Total of 63 credits will be maintained for DC (42 credits) and DE (21 credits) courses while the rest of the credits will be kept for IC and other institute level courses (97 credits). Additional 12 credits will be introduced for UG research program to attract motivated research students towards research career at early stage by offering B.Tech. Honors.

List of courses:

Core Courses	Discipline Electives	IC Courses/Other
1. Physics of Solids 2. Materials Synthesis and Characterization (2 + 2 credits of Lab) 3. Phase Transformations 4. Thermodynamics and Kinetics of Materials 5. Durability Behavior of Materials (2 + 1 credits of Lab) 6. Quantum Mechanics and Applications 7. Functional Properties of Materials (2 + 2 credits of Lab) 8. Extraction and Materials Processing (2 + 2 credits of Lab) 9. Mechanics of Solids 10. Transport Phenomena 11. Computational Materials Science (2 + 2 credits of Lab) 12. Product Realization	1. Smart Materials and Actuators 2. Biomaterials 3. Thin Film Technology 4. Carbon Materials 5. Materials Modelling 6. Ancient Materials 7. Structural Materials <i>(See the other discipline elective courses under the specialization baskets below)</i>	1. Calculus 2. Complex variables and Vector Calculus 3. Linear Algebra 4. ODE 5. Engineering Graphics and Design 6. Introduction to Python and Data Science 7. Applied Chemistry 8. Applied Electronics 9. Applied Electronics Lab 10. Probability and Statistics 11. Materials Science for Engineers 12. Foundations of Design and Practicum 13. Physics Practicum 14. Design Practicum 15. Machine Learning 16. Reverse Engineering

Technology (2 + 2 credits of Lab) 13. Materials Science for Engineers (IC 241) (3 credits) 14. Reverse Engineering (1 credit)		17. MTP-1 and MTP-2 18. HSS courses 19. IKSHMA Course 20. Mechanics of Rigid Bodies
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The elective courses are organized under 4 optional specialization baskets as shown below.

B.Tech. in Materials Science and Engineering with Specialization in "X"

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X: Product Design and Manufacturing

1. Fundamentals of Product Design
2. Prototyping methods
3. 3D Printing of Diverse Materials
4. Advanced Manufacturing Processes
5. Nanomanufacturing

X: Quantum Materials and Semiconductor Devices

1. Materials for Quantum Technologies
2. Sensor Materials and Technologies
3. Semiconductor Materials and Devices
4. Quantum Optics and Devices
5. Mesoscopic Physics and Quantum Transport

X: Clean Energy and Sustainable Materials

1. Urban Mining and Sustainability
2. Energy Conversion and Storage Technologies
3. Recycling and Circular Economy
4. Environmental Implication of Materials
5. Green Processes and Decarbonization

X: ICME – Integrated Computational Materials Engineering

1. Artificial Intelligence for Materials Science
2. Modelling and Simulations
3. Finite Element Method in Engineering
4. Density Functional Theory
5. Computational Materials Laboratory

- 5 courses from the proposed four elective baskets will enable specialization in B.Tech.
- It is optional and number of specialization baskets will be operated based on the available resources
- No additional credits are needed for B.Tech. with specialization in "X"

B.Tech. (Materials Science and Engineering) –1st Semester						
S.No	Code	Course Name	Lecture	Tutorial	Practical	Credit
1	ICXXX	Calculus	2	0	0	2
2	ICXXX	Complex variables and Vector Calculus	2	0	0	2
3	IC140	Engineering Graphics	2	0	3	4
4	IC152	Introduction to Python and Data Science	3	0	2	4
5	IC131	Applied Chemistry for Engineers (basket - 1)	2.5/3	0.5/0	0	3
6	IC241	Materials Science for Engineers (basket-2) (DC)	3	0	0	3
7	YYXXX	Ikshma Course	3	0	0	3

Total Credits: 21

B.Tech. (Materials Science and Engineering) –2nd Semester						
S.No	Code	Course Name	Lecture	Tutorial	Practical	Credit
1	ICXXX	Linear Algebra	2	0	0	2
2	ICXXX	ODE & Integral Transforms	2	0	0	2
2	IC161	Applied Electronics	3	0	0	3
3	IC 161P	Applied Electronics Lab	0	0	3	2
4	IC252	Probability and Statistics	3	0	2	4
5	ICXXX	Foundations of Design Practicum	1	0	6	4
6	IC221P	Physics Practicum	0	0	3	2
7	HSXXX	HSS Course	3	0	0	3

Total Credits: 22

B.Tech. (Materials Science and Engineering) –3rd Semester

S.No	Code	Course Name	Lecture	Tutorial	Practical	Credit
1	IC201P	Design Practicum	0	0	6	3
2	IC272	Machine Learning	2	0	2	3
3	IC XXX	Mechanics of Rigid Bodies (basket-2)	3	0	0	3
4	DC-1	Physics of Solids	3	0	0	3
5	DC-2	Quantum Mechanics and Applications	3	0	0	3
6	DC-3	Materials Synthesis and Characterization	3	0	2	4
7	HSXXX	HSS Course				3

Total Credits: 22

B.Tech. (Materials Science and Engineering) – 4th Semester

S.No	Code	Course Name	Lecture	Tutorial	Practical	Credit
1	DC-4	Mechanics of Solids	3	0	0	3
2	DC-5	Thermodynamics and Kinetics of Materials	3	0	0	3
3	DC-6	Functional Properties of Materials	3	0	2	4
4	DC-7	Extraction and Materials Processing	3	0	2	4
5	HSXXX	HSS Course				3
6	DE-1	Discipline Elective				3
7	FE-1	Free Elective				2

Total Credits: 22

B.Tech. (Materials Science and Engineering) – 5th Semester

S.No	Code	Course Name	Lecture	Tutorial	Practical	Credit
1	DC-8	Phase Transformations	3	0	0	3
2	DCX-9	Transport Phenomena	3	0	0	3
3	DC-10	Computational Materials Science	3	0	2	4
4	DC-11	Durability Behavior of Materials	3	0	2	4
5	DE-2	Discipline Elective				3
6	DE-3	Discipline Elective				3
7	FE-2	Free Elective				2

Total Credits: 22

B.Tech. (Materials Science and Engineering) – 6th Semester

S.No	Code	Course Name	Lecture	Tutorial	Practical	Credit
1	DC-12	Product Realization Technology	3	0	2	4
2	DE-4	Discipline Elective	0	0	3	3
3	DE-5	Discipline Elective	3	0	0	3
5	FE-3	Free Elective	3	0	0	3
6	HSXXX	HSS Course				3
7	ISTP					4

Total Credits: 20

B.Tech. (Materials Science and Engineering) – 7th Semester

S.No	Code	Course Name	Lecture	Tutorial	Practical	Credit
1	DE-6	Discipline Elective				3
2	FE-4	Free Elective				3
3	FE-5	Free Elective				3
4	MTP-1	MTP-1				4
5	IC 010	Internship				2

Total Credits: 15

B.Tech. (Materials Science and Engineering) –8th Semester						
S.No	Code	Course Name	Lecture	Tutorial	Practical	Credit
1	DE-7	Discipline Elective				3
2	FE-6	Free Elective				3
3	FE-7	Free Elective				3
4	FE-8	Free Elective				3
5		MTP-2				4

Total Credits: 16

Grand Total: 160 credits for B.Tech. Materials Science and Engineering

Brief details about the Elective Specializations are shown below.

1. B.Tech. Specialization in Product Design and Manufacturing

To establish a program bridging a gap between industrial product design and its manufacturing. The program minor will be oriented towards conceptualizing and nurturing a design idea by making it progress through various design stages. The outcome of such a practice will be a product prototype that can be upscaled to an industrial level. The students opting for this minor will aim at working in close collaboration with the incubation center (catalyst) to support the technology transfer and/or lead to the establishment of the start-ups. Such a program will be in line with the Make-in-India objective. The engineering students, irrespective of their branch can engage themselves right from the first semester into a design philosophy which they can slowly nurture over the years ending up with a ready to launch a product by the end of their undergraduate degree.

2. B.Tech. Specialization in Clean Energy and Sustainable Materials

Materials that can be produced at a large scale in an eco-friendly manner and a reduced dependence on non-renewable sources are designated as sustainable materials. The idea of sustainable materials and production is an emerging concept in the 21st century that is inspired by the rapid global growth in the production of commercial goods featuring advanced functionalities. Sustainable materials are expected to be compatible with low energy consuming manufacturing processes that generate minimal waste. At the same time, their recyclability is an essential aspect, in order to minimize waste generation. In this specialization, courses on a range of environment-friendly materials, non-hazardous materials, waste-derived materials, recyclable and biodegradable materials, and associated process optimization will be offered. The student will also receive training on designing and developing alternative materials for existing products. In addition, general waste management processes, introduction to energy management and associated technologies will be covered. Essential energy and environment related policies, both Indian and international, will also be touched upon.

3. B.Tech. Specialization in Quantum Materials and Semiconductor Devices

The advancement of the human civilization has been immensely influenced by the discovery of new materials. Almost all the new technological developments rely on the exotic properties of materials. Materials such as Magnets, Multiferroics, Thermoelectrics, Optical, Piezoelectrics, superconductors, nanomaterial, low dimensional materials etc. whose properties cannot be explained within the pursuit of Newtonian physics, and the principles of quantum mechanics are invoked to understand their behavior, are termed as quantum materials. The technology

using new quantum materials would lead to the next level of revolution in technologies for energy, electronic sensors, quantum computers, optical fiber, optical sensors, levitating trains, nano-electronics, information infrastructures etc. The new technology harnessing the quantum properties of materials is expected to be more powerful in comparison to its classical counterparts. In order to harness the quantum properties of materials for the future technology, there is need to understand, explore and tailor the new property of material as well as the fabrication of the suitable devices. The proposed minor in B.Tech. program will give an early exposure to the students to this developing field of advance technology.

4. B.Tech. Specialization in Integrated Computational Materials Engineering

The integrated computational materials engineering covering variety of theoretical and simulation approaches at different length scales with the use of different computational tools would attract students who are interested to apply their computational skills to scientific problems in Materials Science. In addition to conventional methods such as density functional theory, molecular dynamics, modeling and simulations and finite element methods, emerging subjects like application of AI and machine learning in materials science would be introduced. Materials discovery has always been challenging problem based on its numerous real life target applications. Scientist are trying to accelerate the research with use of artificial intelligence (AI) and machine learning (ML) to adapt the materials fabrication which could meet the demand of current century. tudents will be trained in multiple computational packages to solve materials engineering problems from atomic, molecular scales to macroscopic length scales.