INDIAN INSTITUTE OF TECHNOLOGY MANDI

KAMAND, DISTT. MANDI – 175075 (HIMACHAL PRADESH)

MINUTES OF 48TH BOARD OF ACADEMICS MEETING

VENUE	:	A-4 (SC) and GUEST HOUSE (NC) CONFERENCE ROOM + ONLINE
DATE	:	10TH JANUARY, 2023 (TUESDAY)
TIME	:	10:00 A.M.

Following members attended the meeting

Sl. No	Responsibilities	Name
1	Dean Academics	Prof. Rahul Vaish
2	Associate Dean (Research)	Dr. Amit Jaiswal
3	Associate Dean (Courses)	Dr. P. Anil Kishan
4	Chairman Course Proposal Committee	Dr. Venkata Uday Kala
5	Nominee-1: School of Chemical Sciences	Dr. Bhaskar Mondal
6	Nominee-2: School of Chemical Sciences	Dr. Garima Agrawal
7	Nominee-1: School of Biosciences and Bioengineering	Dr. Sumit Murab
8	Nominee-1: School of Mathematical and Statistical Sciences	Dr. Rajendra K Ray
9	Nominee-2: School of Mathematical and Statistical Sciences	Dr. Syed Abbas
10	Nominee-2: School of Civil and Environmental Engineering	Dr. Prasanna Rousseau
11	Nominee-1: Centre of AI and Robotics	Dr. Narendra Kumar Dhar
12	Academic Affairs Secretary	Mr. Naveen S. Thota
13	Deputy Registrar (Academics): Secretary	Mr. Suresh Rohilla

Following members could not attend the meeting

Sl. No.		Name	
1	Chairman Senate Library Committee	Dr. Rajeshwari Dutt	Member
2	Nominee-1: School of Computing and Electrical Engineering	Dr. Padmanabhan Rajan	Member
3	Nominee-2: School of Computing and Electrical Engineering	Dr. Gopi Shrikanth Reddy	Member
4	Nominee-1: School of Physical Sciences	Dr. Arko Roy	Member
5	Nominee-2: School of Physical Sciences	Dr. Girish Sharma	Member
6	Nominee-2: School of Biosciences and Bioengineering	Dr. Kasturi Prasad	Member
7	Nominee-1: School of Civil and Environmental Engineering	Dr. Maheshreddy Gade	Member
8	Nominee-1: School of Mechanical and Materials Engineering	Dr. Gaurav Bhutani	Member
9	Nominee-2: School of Mechanical and Materials Engineering	Dr. Sudhir Pandey	Member
10	Nominee-1: School of Humanities & Social Sciences	Dr. Rajeshwari Dutt	Member
11	Nominee-2: School of Humanities & Social Sciences	Dr. Ramna Thakur	Member
12	Nominee-2: Centre of AI and Robotics	Dr. Jagadeesh	Member
13	Nominee-1: IKSHMA	Dr. Arnav Bhavsar	Member
14	Industry Member – 1	Dr. Nadeem Akhtar	Member
15	Research Affairs Secretary	Mr. Shubham Ranjan	Member

Special Invitee

Sl. No.	Name	
1	Dr. Kaushik Halder	Asst. Prof. SCEE
2	Dr. Satvasheel Powar	Asso. Prof. SMME
3	Dr. Manoj Thakur	Asso. Prof. SMSS
4	Dr. Atul Dhar	Asso. Prof. SMME
5	Dr. Tushar Jain	Asso. Prof. SCEE
6	Dr. Sampat Kumar Sharma	Asst. Prof. SMSS
7	Dr. Amit Balkrishna Pawar	Asst. Prof. SCS
8	Dr. Samir Shukla	Asst. Prof. SMSS
9	Dr. Pradeep Kumar	Asso. Prof. SMME
10	Dr. Muslim Malik	Asso. Prof. SMSS
11	Dr. Vivek Gupta	Asst. Prof. SCENE
12	Dr. Deepak Swami	Asso. Prof. SCENE
13	Dr. Radhe Shyam Sharma	Asst. Prof. SCEE

PART-A

(Issues discussed by the Board of Academics when the Student Members were present)

48.1 Confirmation of the minutes of 47th meeting of the Board of Academics:

The minutes of the 47th meeting of the Board of Academics held on 06th and 07th September, 2022 were confirmed.

48.2 To consider the proposal of new Bachelor of Architecture (B.Arch.) programme:

Dr. Deepak Swami presented a proposal to the Board of Academics regarding Bachelor of Architecture (B.Arch.) programme. After due deliberations, it was suggested to rework on the proposal and present the same in a subsequent BoA meeting.

48.3 To consider the proposal of new branch in B.Tech. programme i.e., B.Tech in Materials Science and Engineering:

Dr. Viswanath Balakrishnan, presented the proposal of new branch B.Tech. in Materials Science and Engineering. After due deliberations, the BoA recommended the proposal with minor modification for consideration of the Senate and its approval.

The modified proposal is placed as **Annexure – A.**

48.4 To consider the proposal of new branch in B.Tech. programme i.e., B.Tech in General Engineering:

Dr. Satvasheel Powar, presented the proposal of new branch B.Tech. in General Engineering. After due deliberations, the BoA recommended the proposal with minor modification for consideration of the Senate and its approval.

The modified proposal is placed as **Annexure – B.**

48.5 To consider the proposal of new BS-MS in Chemical Sciences:

Dr. Bhaskar Mondal, presented the proposal of new BS-MS in Chemical Sciences. After due deliberations, the BoA recommended the proposal with minor modification for consideration of the Senate and its approval.

The modified proposal is placed as **Annexure – C.**

48.6 To consider the proposal of new M.Tech. in Control and Automation programme:

Dr. Tushar Jain, presented the proposal of new M.Tech. in Control and Automation programme. After due deliberations, the BoA deferred the programme in the light of new proposal of M.Tech./M.A/M.Tech (Research) with Specialization being considered by the Senate.

48.7 To consider the proposal of new M.Tech (by Research) programme in Robotics in Centre for AI and Robotics (CAIR):

Dr. Narendra Dhar, presented the proposal of new M.Tech. (by Research) programme in Robotics in Centre for AI and Robotics (CAIR). After due deliberations, the BoA deferred the programme in the light of new proposal of M.Tech./M.A/M.Tech (Research) with Specialization being considered by the Senate.

48.8 To consider the proposal of new M.Tech. in Geotechnical Engineering programme:

Dr. Kala Venkata Uday, presented the proposal of new M.Tech. in Geotechnical Engineering in School of Civil and Environmental Engineering. After due deliberations, the BoA deferred the programme in the light of new proposal of M.Tech./M.A/M.Tech (Research) with Specialization being considered by the Senate.

48.9 To consider the proposal of new M.Tech. in Environmental Engineering programme:

Dr. Vivek Gupta, presented the proposal of new M.Tech. in Environmental Engineering in School of Civil and Environmental Engineering. After due deliberations, the BoA deferred the programme in the light of new proposal of M.Tech./M.A/M.Tech (Research) with Specialization being considered by the Senate.

48.10 To consider the proposal of new branch in B.Tech. programme i.e., B.Tech. in Maths and Computing:

Dr. Muslim Malik, School Chair of Mathematical and Statistical Sciences presented the proposal of new branch in B.Tech. in Maths and Computing. After due deliberations, the BoA recommended the proposal with minor modification for consideration of the Senate and its approval.

The modified proposal is placed as **Annexure – D.**

48.11 To consider the proposal of new M.Tech. in Computational Mechanics programme:

Dr. Atul Dhar, School Chair of Mechanical and Materials Engineering presented the proposal of new M.Tech. in Computational Mechanics. After due deliberations, the BoA deferred the programme in the light of new proposal of M.Tech./M.A/M.Tech (Research) with Specialization being considered by the Senate.

48.12 Any other item with the permission of the Chair.

With the permission of the Chairman, the BoA deliberated on the following points:

(i) To consider the proposal of M.Tech. (by Research) with Specialization:

Dr. P Anil Kishan, Associate Dean (Courses) presented the proposal of M.Tech. (by Research) degree with specialization. After due deliberations, the BoA recommended the given proposal for consideration of the Senate and its approval.

Institute has a program M.Tech (by Res.) which has a major dissertation component. It is quite a good program. However, it has low intake. It may be due to lack of awareness among students/ applicants in the country unlike M.Tech course based programs. In order to attack students in this program, there is a need to alter the program as per students and company/institute requirements.

This proposal proposes specialization options in this PG degree as follows:

		Requirements
M.Tech (By Res)	Degree can be awarded as it is (with the thesis dissertation)	15 credits +1 RM , specified by guide
M.Tech (By Res) with specialization in specific areas	Degree can be awarded as **M.Tech (by Res) in Thermal Engg.** along with dissertation title	15 credits (**recommended by APC in the specialization area e.g thermal courses of 5 level or more)** +1 credit Res. Meth.

This will help us to attract more students who wish to pursue their career in industry while at the same time it will serve well for higher education.

(ii) **To consider the proposal of extension in degree duration:**

Dr. P Anil Kishan, Associate Dean (Courses) presented the proposal of extension in B.Tech. programme after four years. After due deliberations, the BoA recommended the given proposal for consideration of the Senate and its approval.

- Currently student has freedom to extend their degrees upto 6 yrs (UG) and 3 yrs (PG) without obtaining the permission from Dean (Academics).
- In case of PhD registration after 5 yrs, scholar has to take prior permission for more 2 yrs.
- It will help us to track the defaulter cases in UG/PG programme.

Permission need to be sought 15 days prior to end of registration date.

Programme	**Minimum Duration**	**Maximum duration**
Under graduate (B.Tech.)	4 yrs	Can be extended upto 2 more years based on the recommendation of Faculty advisor and School Chairs. Prior approval of Dean Academics is necessary for continuing registration after 4 yrs.
Postgraduate degrees (course based) (M.Tech, MSc, MBA, MA etc)	2 yrs	Can be extended upto 1 more year based on the recommendation of Faculty advisor/ supervisor and School Chair. Prior approval of Dean Academics is necessary for continuing registration after 2 yrs.

(iii) To consider the proposal of modification in the programme M.Tech. in Mechanical Engineering with Specialization in Energy Systems:

Dr. Atul Dhar, Chair SMME, presented the proposal of modification in the curriculum of M.Tech. in Mechanical Engineering with Specialization in Energy Systems.

1	**Replacing Core Course HS540**: Energy: Environment Policy and Law with Open Elective Courses such as: –ME513 Finite Element Method for Engineers –ME601: Advanced Finite Element Methods –HS540 is suggested to be included in the list of electives

	–Any other course with sufficient out of discipline exposure
2	**Replacing ME631**: Heat Transfer and Fluid Flow in Energy Systems with ME604: Experimental Methods in Thermal Engineering

The motivation for this change is to effectively handle the teaching load of the faculty of SMME by replacing the course with similar course content. After due deliberations, the BoA recommended the proposal for consideration of the Senate and its approval.

(iv) To consider the revision in course curriculum of M.Sc. in Applied Mathematics:

Dr. Muslim Malik, presented a modification in course curriculum of M.Sc. in Applied Mathematics. After due deliberations, the BoA recommended the proposal for consideration of the Senate and its approval. The proposal is placed as **Annexure-E**.

PART-B

(Issues discussed by the BoA without the Student Members being present)

-NIL-

The meeting ended with a vote of thanks to and by the Chair.

Secretary, Board of Academics

Chairman, Board of Academics

Proposal for B. Tech. in

Materials Science and Engineering

School of Mechanical and Materials Engineering (SMME)

Indian Institute of Technology Mandi

Programme Proposal Form

Name of the New Proposed Program: B.Tech. in Materials Science and Engineering
(Four Years Undergraduate Program)

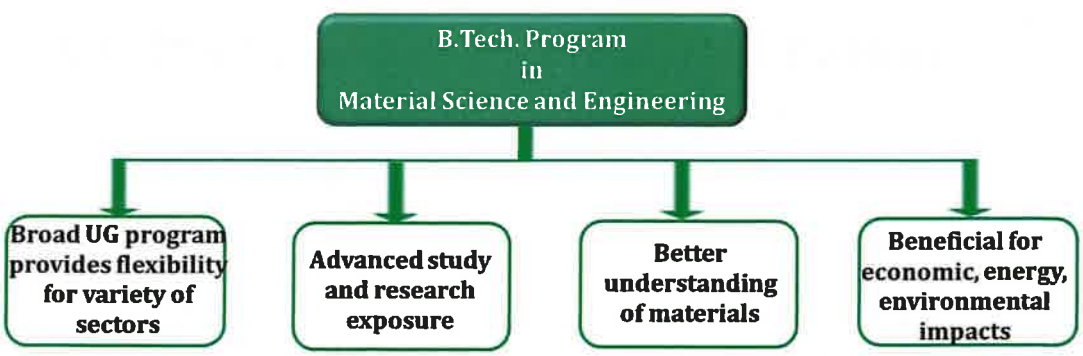
I. General Information:

Name (s) of prosper school: School of Mechanical and Materials Engineering (SMME)

II. Program Description:

A. Provide a justification/rationale for the program. How does the program relate to the mission of the IIT Mandi?

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.



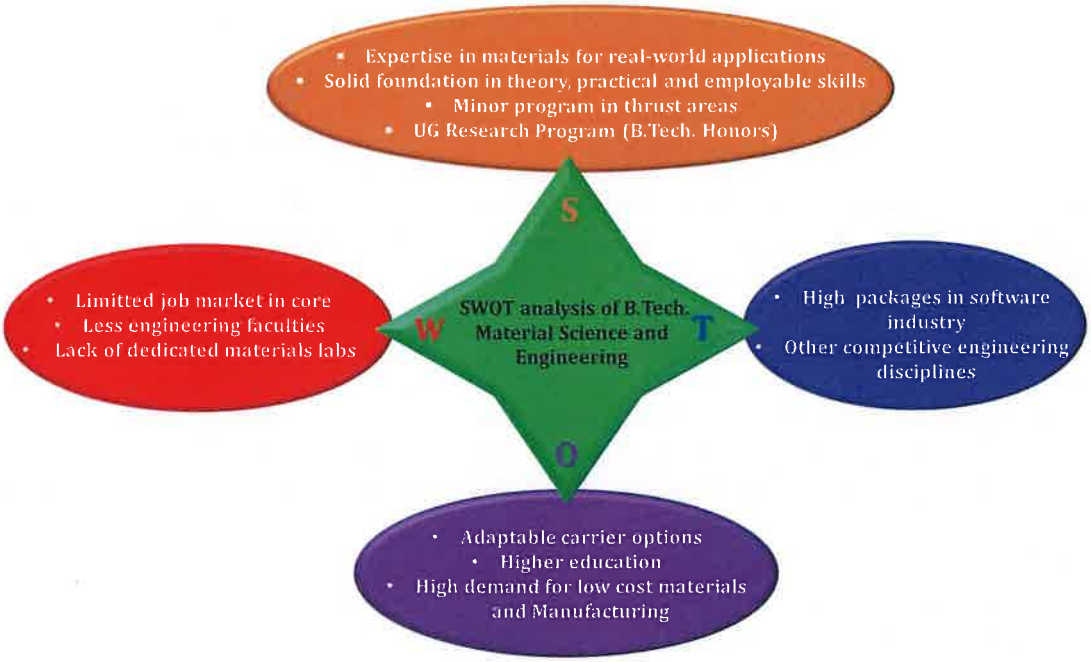
B. SWOT analysis of the program

The purpose of SWOT analysis is to see how Material Science and Engineering can be implemented in the IIT Mandi's education system.

ADVANTAGES (Strengths-Opportunities)	DISADVANTAGES (Weakness – Threats)
The coursework will cover fundamental sciences and mathematics relevant to Materials Science and Engineering, as well as provide an in-depth understanding of key material properties and behaviours.	Lack of dedicated teaching laboratories for providing hands on training to UG students to conduct experiments, familiarize material processes and applications.
This program will educate undergraduate students to tackle grand challenges in sustainability and clean energy, quantum materials and devices, artificial intelligence and smart materials, characterization tools, product design and manufacturing by selected elective courses in different streams.	Less number of faculty members in the core materials engineering area.
Our graduate students will be trained in R&D to become researcher, innovators and entrepreneurs who consistently conduct research, develop novel materials and processes of all kinds towards positive economic and social impact. This will be achieved by attracting highly motivated students in UG research program under B.Tech. Honors program.	Limited job market in the core area of materials as well as high packages in software and other competitive industries.

Some of the weaknesses could be addressed by establishing good UG teaching laboratories that caters the need of large number of UG students. Similarly, hiring few more engineering faculty members in the areas of computational materials, functional materials and metallurgy will strengthen the core discipline and also reduce the teaching dependencies over the associated faculty members from different Schools.

While the limited job market in the core area of materials may not be changeable at our end, the broad UG curriculum with technical skills, elective specializations and UG research program etc will likely to increase the employability of our students in various sectors. Further, more focused efforts are needed to expand the network on identified sectors such as Semiconductors, Manufacturing, Structural Materials/Steels, Automobiles, Energy and Waste Management in order to improve the placements. For example, core industries such as Saint Gobain, Aditya Birla, Applied Materials, Tata Steel, Jindal Steel, 3M, Intel, Global Foundries and Micron might be contacted by faculty advisors to increase our engagements with them for better career opportunities.



C. Justification with respect to New National Education Policy (NEP) mandates

One of the major key points of the new national education policy (NEP) is transformational reforms in school and higher education systems in the country and also to foster interdisciplinary education. In the proposed B.Tech. program, greater emphasis is given to connection between the fundamentals and analytical abilities, critical thinking, and research. As per the recent developments, the rigid boundaries among different disciplines are diminishing, the subject of materials science and engineering interdisciplinary by itself and would provide broad knowledge to UG students. The field of materials science and engineering gives flexibility for work in a variety of sectors. Graduates receive an in-depth understanding of fundamental sciences and engineering due to the program's resilience. Due to the program's integration of the fundamental sciences and engineering, graduates' benefit from having a degree that allows them to be flexible enough to work in a variety of industries while also being highly qualified for advanced study and research.

D. Provide a mission statement for the program. Include educational and learning objectives

The Bachelor of Technology in Materials Science and Engineering program's mission is to prepare graduates with a solid foundation in materials science and engineering to fulfill the demands of business and government as well as to pursue further academic study in fields connected to materials. This will be done by giving students access to up-to-date curricula, state-of-the-art labs, chances to collaborate on cutting-

edge research with eminent faculty mentors, and opportunities to get involved in leadership and service projects.

The educational and learning objectives of the B.Tech.in Materials Science and Engineering program are:

- Our graduates will quickly advance to leadership positions in organizations that deal with materials in the industry, academia, government, and other fields of endeavor.
- With the help of the process-structure-properties-performance paradigm, our graduates will be entrepreneurs who continuously research, develop, and produce novel materials of all kinds, having a beneficial economic and social influence on their industry and society as a whole.
- Our graduates will be trained to become world leaders who integrate cutting-edge engineering and material breakthroughs that are improving society and the state of the human condition while working with diverse, multidisciplinary teams.

E. Credit Structure of the programme.
The typical credit structure of the institute will be followed as shown below.

Division	**Sub division**	**Credits**
Institute Core	IC Compulsory	39
	IC Baskets	09
	Humanities and Social Sciences (HSS)	12
	Indian Knowledge System (IKS)	03
Discipline	Discipline Core (DC)	42
	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.

F. List of courses proposed

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 + 2 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 Technology (2 + 2 credits of Lab)	1. Smart Materials and Actuators 2. Biomaterials 3. Thin Film Technology 4. Carbon Materials 5. Materials Modelling 6. Ancient Materials 7. Structural Materials ***(See the other discipline elective courses under the specialization baskets below)***	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 17. MTP-1 and MTP-2 18. HSS courses 19. IKSHMA Course 20. Mechanics of Rigid Bodies

The elective courses are organized under 4 optional specialization baskets as shown below.

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

ELECTIVE BASKETS

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"

G. Provide a list of any current courses that would be cross-listed with the program:

1. Structure Property Correlations
2. Durability Behavior of Materials
3. Product Realization Technology
4. Functional Materials
5. Quantum Mechanics and Applications
6. Mechanics of Solids

Some of these courses are offered for M.Tech. wherein energy is added and may need to be edited suitably to make it common for both B.Tech. and M.Tech. programs.

H. What, if any, new courses will be required for the program? A separate course proposal is required for each new required course.

Being a new B.Tech. program, around 20 new courses will be proposed with required details. At the same time, some of the existing courses in the subject of Mechanical, Manufacturing, Energy Engineering and Physics will be adopted as per the requirement. Separate course proposals are being prepared and will be submitted in the due course.

I. Provide a sample academic plan for students completing the academic program being proposed.

The overall academic structure of B.Tech. Materials Science and Engineering is being worked out in cognizance with other B. Tech programs such as Mechanical Engineering and Engineering Physics. The semester wise detailed academic structure is shown in the table below for 8 semesters.

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)	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

Additional credits for B.Tech. Honors_ UG Research Program (Semester 5th to 8th): 12 Credits

J. If established at other institutions, please submit sample programs from those institutions.

1. In what ways is this proposal consistent with those programs?

UG program in Materials Science and Engineering is a common program in both national and international institutes. At present, 16 out of 23 IITs offer B.Tech. in Materials/Metallurgy branch. Similarly, 15 out of 31 NITs have B.Tech. in Materials/Metallurgy. In addition, many leading private institutes such as VIT, Amirta Vishwa Vidyapeetham, SRM, Amity University, Thapar Institute of Engineering and Technology, BITS Pilani and Sastra University, also have B.Tech. in Materials subject. There is a general trend, moving from metallurgy to materials science and engineering in UG program both nationally and globally as advanced materials are gaining more attention in industry. On this context, the proposed B.Tech. in Materials Science and Engineering consistent with the existing program in other places in terms of core courses and laboratory courses.

2. In what ways is this proposal different from those programs? Please explain those differences.

B.Tech. programs established in some of the older institutes are more oriented towards metallurgy and newly launched programs (for example, B.Tech. in Materials Science and Engineering at IIT Delhi in 2020) are focusing of advanced materials, functional materials, semiconductor devices, polymers, composites and energy etc with core courses in structure, processing and properties of matter etc. Many of the older IITs also revised their curriculum to make it suitable for the present scenario.
In 2020, a national level workshop was organized to develop a model curriculum for Materials Science and Engineering by Indian Academy of Sciences at Coorg (Annexure – I). The report reviewed the existing curriculum and come up with several important aspects to be implemented to make the B.Tech. in Materials

Science and Engineering more attractive for students with features of fundamentals, mathematical and computational tools, laboratory sessions, projects to cover broad spectrum of knowledge. The following guidelines are suggested to improve the B.Tech. Materials Science and Engineering curriculum.

(i) The compulsory department curriculum should adopt a unified approach towards materials education. Fundamental concepts related to structure, properties and processing for different types of materials should be consolidated and taught together, and not as separate courses. For example, 'structure of materials' can be taught together for metals, ceramics, and semiconductors.

(ii) Courses should be quantitative, wherever possible. Emphasis on quantitative correlations between structure, property and process should be encouraged. Excessive memorizing should be discouraged. In fact, concepts should be inculcated through quantitative projects and assignments.

(iii) In manufacturing and extractive metallurgy courses, a unit operation based generalized approach is recommended. This may also minimize the number of courses without sacrificing the content.

(iv) Balancing of lectures, tutorials, and experiments is critical.

(v) Computational and mathematical skills acquired during the core courses should be utilized in making the departmental courses more analytical. Mathematical concepts to be applied in each course should be clearly identified and reinforced during teaching of the course.

(vi) There should be an adequate emphasis on process design in all areas of materials and metallurgy. This implies that students should also have a good understanding of transport phenomena and solid mechanics.

(vii) Teaching methodology should keep pace with changing times. Innovative ideas are necessary to sustain students' interest in courses, for example, by incorporating small projects in the courses wherever possible.

(viii) The concept of modular courses may be implemented. Here, courses can consist of topics around theme that may be taught by multiple instructors. Also, modular course avoids repetition of course contents between similar courses in one domain.

(ix) Laboratories could be conducted in such a way that teaching of key techniques of laboratories is followed by their execution and learning in the form of a capstone project.

The report also suggested a model template for B.Tech. Materials engineering curriculum consisting of 12 core courses, labs and elective courses that are presented in page number 20 of Annexure -I. The proposed B.Tech. in Materials Science and Engineering at IIT Mandi targets to go further in this direction focusing on advanced materials. Some of the uniqueness of the proposed programs are as follows.

- Good balance of core courses in the area of materials and allied engineering courses in mechanical, manufacturing, Physics etc.

- More credits for laboratory courses in the discipline to provide practical knowledge and employable skills
- Elective courses are chosen in the form of 4 different baskets to cover wider areas of interest in emerging areas such as Manufacturing, Sustainability, Quantum Materials and Integrated Computational Materials.
- UG research program with additional 12 credits to provide early research exposure to the highly motivated students as B.Tech. honors in major research streams (B.Tech. in R&D).

III. Faculty and Governance:

Provide a list of the faculty available to teach courses for this program.

1. Dr. Jaspreet Randwal(SMME)
2. Prof. Rahul Vaish (SMME)
3. Dr. Ranbir Singh (SMME)
4. Dr. Rik Koner (SMME)
5. Dr. Sudhir Pandey (SMME)
6. Dr. Swati Sharma (SMME)
7. Dr. Viswanath Balakrishnan (SMME)
8. Dr. Ravindra (Newly Recruitment, SMME)
9. Dr. Dheeraj (New Recruitment, SMME)
10. Dr. Shivam (New Recruitment, SMME)
11. Dr. Vishal Chauhan (SMME)
12. Dr. Satvasheel Pawar (SMME)
13. Dr. Prateek Saxena (SMME)
14. Dr. Sarthak Nag (SMME)
15. Dr. Sunny Zafar (SMME)
16. Dr. C.S. Yadav (SPS)
17. Dr. Ajay Soni (SPS)
18. Dr. Venkata Krishnan (SCS)
19. Dr. Aditi Halder (SCS)
20. Dr. Bhaskar Mondal (SCS)
21. Prof. Satinder Sharma (SCEE)

In case of interdisciplinary program, mention governances and execution mechanism of the programme:

Materials Science and Engineering program is an interdisciplinary program and good number of the allied courses will be taught by faculty members from Mechanical Engineering, Electrical Engineering, Physics and Chemistry. While the core faculty in SMME will take a lead in governance and overall coordination, the associated faculty members from other streams will be contributing for teaching activities as per the need and their availability to bring out the best in this interdisciplinary program. Recruitment of around 5 more faculty members in the area of Materials Science and Engineering with

expertise on computational materials science and other advanced areas are needed in the next few years.

IV. Student interest:

What measures of student interest in the program are there? How/why are the proposers convinced that students would want to take this program of study? (Attach Career and Placement Cell recommendation or any other)

While the conventional and major engineering streams such as Civil, Mechanical, Electrical and Computer would continue to lead the overall engineering education, allied branches such as chemical, materials, bio are gaining interest in the recent past. The proposed B.Tech. in Materials Science and Engineering would be attractive to the students those have inclination towards basic sciences as well as engineering. Being an interdisciplinary program, this also will cater to the students who would like to peruse different fields at the master level. However, the job market in industry for materials core area is relatively limited in India. To address this issue and provide broader expertise, 4 different specialization programs via elective baskets are added as part of the B.Tech. program. With such exposure, the employability of students is expected to be higher considering the developments in semiconductors and manufacturing sectors. Finally, our UG program at IIT Mandi is sufficiently broad covering key elements of general engineering, sciences, humanities and more importantly computer and data sciences that would enable students to get jobs in non-core areas/software sectors as it is a common trend over a decade.

Resources:

Additional requirements of laboratory space with justification (name of the labs)

1. Materials Processing (required space = 100 sqm)
2. Mechanical Testing Laboratory (required space = 100 sqm)
3. Functional Materials Laboratory (required space = 100 sqm)
4. Product Realization Technology (required space = NA)
5. Computational Materials Science (required space = NA)
6. Materials Synthesis and Characterization (required space = NA)

Additional requirements of laboratory fund (recurring and non-recurring) with justification (name of the labs)

1. Materials Processing Lab (Equipment: 1.05 crores)
2. Materials Testing Laboratory (Equipment:1.2 crores)
3. Functional Materials Laboratory (Equipment: 1 crore)
4. Product Realization Technology (Nil)
5. Computational Materials Science (Software packages: 40 lakhs)
6. Materials Synthesis and Characterizations (Nil)
7. Recurring budget (Consumables:20 lakhs)
8. Infrastructure budget for laboratory needs to be worked out by I & S section.

Additional requirements of faculty and non-teaching staff (Numbers and justification)

1. Around 5 more faculty members with engineering background are needed to cater to the broad curriculum with large number of elective courses.
2. For laboratory management, around 2 lab assistants are needed.
3. _____
4. _____
5. _____

V. Origin and development of the proposal:

- Please mention name for faculty involve in developing this proposal.
  1. Viswanath Balakrishnan
  2. Sudhir Pandey
  3. Rik Koner
  4. Jaspreet Kaur
  5. Swati Sharma
  6. Ranbir Singh
  7. Rahul Vaish
  8. Prateek Saxena
- Details of external industry experts and their recommendations (please include their evaluation)
  1. Dr. Hemant Kumar Iyer (Aditya Birla Science & Technology)
  2. Dr. Sandip Chatterjee (Meity)
  3. Dr. Chitra Selvaraj (Saint Gobain)
  4. Dr. Debashish Bhattacharjee (Tata Steel Limited)
- Details of external academia experts and their recommendations (please include their evaluation):
  1. Prof. Ashish Garg (IIT Kanpur)
  2. Prof. Prita Pant (IIT Bombay)
  3. Prof. Ranjith Ramadurai (IIT Hyderabad)
  4. Prof. Nityanand Gowsami (IIT Delhi)
  5. Prof. Krishanu Biswas (IIT Kanpur)

- Proposers' faculty name and their signatures:

Name of Faculty members	**Signatures**
1. Viswanath Balakrishnan	
2. Sudhir Pandey	
3. Rik Koner	
4. Jaspreet Kaur	
5. Swati Sharma	
6. Ranbir Singh	
7. Rahul Vaish	

8. Prateek Saxena	
9.	

Recommendations of Chairperson of School/ Centre

Signature with Date:

Dean (Students) recommendations on availability of hostels and other requirements

Signature with Date:

Associate Dean (Courses) recommendation on class rooms availability and other academic infrastructure requirements

Signature with Date:

Dean Finance recommendation on financial aspects (if any)

Signature with Date:

Dean Academics recommendations:

Recommended/Not Recommended

Signature with Date:

Please enclose additional information if any. ***Final Remarks on Elective Specialization and UG Research Programs***

The employment opportunities and placement aspects are critical for success of the B.Tech. program and the common wisdom is that the core job market in materials science and engineering is relatively less. The proposed broad curriculum addresses this issue by connecting the core materials science with emerging and applied areas that are attractive for industries such as manufacturing, semiconductors and energy etc. Further the computational based courses with blend of AI, machine learning etc would make the students competent in other non-core areas including software industry. As per recent placement records, the core engineering branches such Civil, Mechanical and Electrical also experiences less job offers (less

than 40%) in core engineering industries. While the placement trend may be common among many of the B.Tech. programs due to the job market, it is important to educate students in core branches and specialized areas ensuring the employable skills and knowledge. The proposed B.Tech. specialization with 4 different elective baskets (Product Design and Manufacturing, Clean Energy and Sustainable Materials, Quantum Materials and Devices, and Integrated Computational Materials Engineering is an attempt to train students in targeted areas of industry. Further the proposed B.Tech. Honors with full focus on research program for additional of 12 credits will provide early research exposure to students to increase their opportunities in R&D sector and academics to play a leadership role.

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

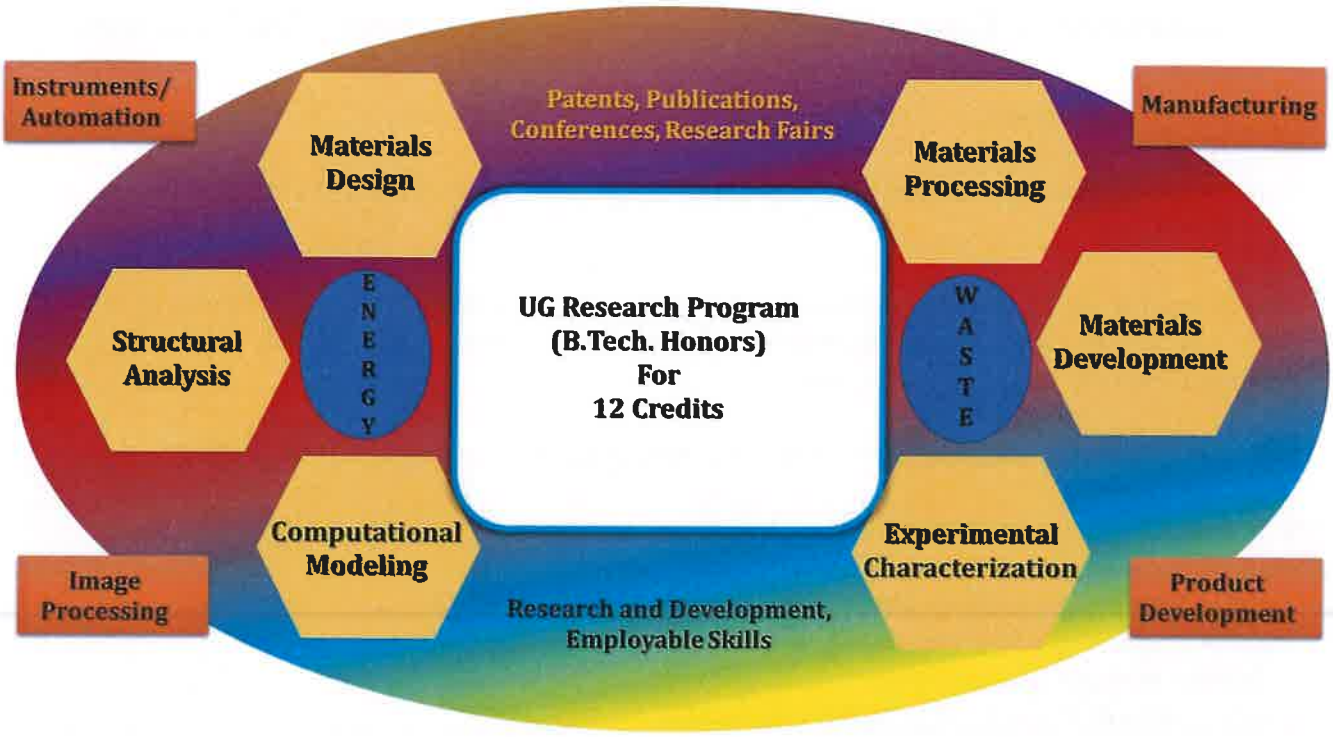
The advancement of the human civilization has been immensely influenced by the discovery of new materials. Almost all the new technological developments rely on the exotic properties of materials. Materials such as Magnets, Multiferroics, Thermoelectrics, Optical, Piezoelectrics, superconductors, nanomaterial, 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.

UG Research Program (B.Tech. Honors in Research and Development)

Attracting and training B.Tech. students in research are important and much-needed steps at institutes national eminence, considering the available research infrastructure and resources. At present, B.Tech. Honors at IIT Mandi is offered with an additional 12 credits of course work. Instead, the prosed B.Tech. Honors in R&D will provide advanced training in the research labs where they can work with research scholars under the supervision of faculty member on cutting edge research areas for 4 semesters.



The student can be assigned a specific guide based on the mutual interest on particular research topic in the end of 3rd semester and carry out the research during 4th, 5th, 6th and 7th semester. The progress may be monitored by the panel chaired by faculty advisor on every semester with weightage of 3 credits per semester. The students are expected to carry out high quality research work on challenging research topics and publish at least one or two research papers or patents for the successful completion of their research project. Since the UG research program is completely optional and meant for engaging highly motivated UG students, suitable criteria, testing the student's interest could be defined based on the "quality of research statement plus presentation" other than CGPA could be defined. In addition to writing research articles/patents on materials science topics, the students may also be encouraged to develop or use software, develop methodology to analyze data, build instruments, prototypes, enable the

automation in existing instruments and demonstrate their applications. The students may also participate in R&D shows, technical completions and conferences.

Annexure – I: External industry experts and their recommendations:

Dr. Sandip Chatterjee,
Director & Scientist-F,
Ministry of Electronics and Information Technology (MeitY), New Delhi 110003.

Thank you for your mail. Happy New Year to you and your family. I have gone through the draft; it is in order and comprehensive. Additionally, I may suggest the following minor modifications for your consideration:

1. Broad B.Tech. Materials Science and Engineering curriculum with minors in "X"

X: Energy and Environmental Sustainability

1. Urban Mining, Secondary Material Extraction & Sustainability
2. Emerging Energy Sources and Devices
3. Energy Storage Technologies
4. Economics of Clean Energy and Environment
5. Environmental Implications of Materials and Solutions

2. B.Tech. Honors for UG Research Program (Research Project with additional 12 credits).

X: Commercialisation of R&D Outcomes (Lab to land)

1. Delivery oriented Project, commercialization & business
2. Technology Proliferation: Technology readiness level (TRL), SRL, MRL
3. SWOT analysis and risk management
4. Materials Development & Environment
5. Sustainable Development Goal: Secondary raw materials

Additionally, I have attached a few topics of interest for your perusal for suitable consideration.

1. Introduction to Waste Management (3 credits) (40 Hours)
2. Global Government policies on E-waste management and Business calculations (3 credits) (40 Hours)
3. SWOT analysis and risk management (2 credits) (30 Hours)
4. Delivery oriented Project, commercialization & business: human resources management

5. Technology Proliferation
6. Introduction to Circular Economy
7. Circular business models
8. National and Global Policy Initiatives & Action Plan on Circular Economy

Response to the comments of Dr. Sandeep Chatterjee:

Dr. Sandip Chatterjee appreciated the proposed programme. He has given minor suggestions on elective courses that are incorporated in the revised proposal. For example, "Urban Mining and Sustainability" course is modified as "Secondary Material Extraction & Sustainability". Similarly, "Environmental Degradation of Materials" course is modified as "Environmental Implications of Materials and Solutions". The suggested courses under commercialisation of R&D outcomes (Lab to land) could be covered in few of the existing courses as modules. Other specific coursed can be added as elective courses in the near future as per the need.

Dr. Hemantkumar Aiyer
Lead Scientist
Aditya Birla Science & Technology Company Limited (ABSTCPL)

Dear Professor Viswanath,
Many thanks for sending this proposal to me for my study.
The proposed course on B Tech degree and also BTech (Hons) in "Materials Science and Engineering" is a well-planned and deeply thought curriculum involving most critical aspects such as Sustainability, Renewable energy, Nanotechnology, Quantum materials, AI, Smart materials, Low power computing, Manufacturing and Productivity.

My few suggestions towards the same are:

1. In teaching sustainability courses, focus should be on Decarbonization, Current and future Net zero activities around the globe, Eco-friendly materials, Energy efficient production methods and CCUS.
2. Productivity related teaching should also address the industry 4.0 practices ... 3D printing and allied topics
3. As it is an engineering course, the modelling element should be made "core course" and not elective.
4. The IIT Mandi department handling this course should leverage industry scientists to bring the students up to date with current Mega-trends in industrial R and D topics and practices. Also same such scientists can be possibly made the adjunct faculty with IIT Mandi.
5. Students should be sent to "compulsory" industry internships to feel the pulse

I will be very delighted to assist you and your faculty and this department for making this course beneficial to your students including the possible internships and connecting you all with anyone in my network and contacts.
Here is wishing a very successful implementation for the same at IIT Mandi (H.P.)

My many thanks and very best regards
Hemantkumar

Response to the comments of Dr. Hemantkumar Aiyer:

Thanks for the appreciation along with valuable comments.

In the light of the received comments, the course on 'Green process and decarbonisation' is added in Clean Energy and Sustainable Materials elective basket.

Regarding the inclusion of course on industry 4.0, we can cover the basics in already proposed courses under the elective basket of product design and manufacturing. The framework of Industry 4.0 is reliant on the following technology pillars namely Autonomous robots, Simulation, System integration, Internet of things, Cybersecurity, Cloud computing, Additive manufacturing, Augmented reality, and Big Data. Some of the above-mentioned pillars are taught as an individual course in various programs at IIT Mandi. A course (core/elective) can be developed where multiple instructors can be involved, each of which can possibly take care of teaching one module which will correspond to one of the pillar technologies of Industry 4.0. Alternatively, some of the technologies discussed above, can also be floated as an independent elective course which can be chosen from the existing curriculum of IIT Mandi.

We agree that the modelling element should be taught as core course and we have one 4 credit course on "introduction to computational methods in materials" wherein computational methods, numerical techniques, finite element analysis, density functional theory, molecular dynamics, Monte Carlo simulations, multiscale modeling, and visualization of large data sets etc along with hands on laboratory session will be addressed. Other specific tools such as MATLAB, Materials Studio etc will be also included.

As suggested, we will target to attract industry/guest lectures to provide R&D exposure to students. Along this line, the industry internship and UG research program etc will be also promoted to strengthen the industry connect in the materials engineering education at IIT Mandi.

Dr. Chithra.S :
Research Scientist,
Saint Gobain Research India

It is a pleasure to review the curriculum as a representative of Saint Gobain Research India. It is a well thought and a detailed document, which comprises of program description with all particulars along with a detailed list of courses. The course list has covered both material science along with advanced engineering topics in a large extent.

The key highlights are

1. SWOT
2. Advanced topics – AI, Data Science, Eng. graphics, Sensor materials

I would like to recommend few other topics like

1. FMEA
2. Statistical analysis & DOE
3. Advanced characterization techniques – Surface analysis
4. Surface engineering
5. Functional materials (covering a larger spectrum & new generation of materials)
6. Piloting ScaleTechnology

Response to the comments of Dr. Chithra.S:

Dr. Chithra liked the programme and appreciated the course structure. She recommended few topics like functional materials, Advanced characterization techniques etc. The few courses have already been added in the revised document. The suggested SWOT analysis will be covered as modules under one of the elective baskets.

Dr Debashish Bhattacharjee
Vice President Technology & New Materials Business
Tata Steel Limited

It is commendable that you and your colleagues at IIT Mandi are proposing to restructure and propose a more employment-friendly BTech course in Materials Science & Engineering. I have two suggestions to improve the course content.

1. While I agree that Metallurgy is getting subsumed under Materials Science & Engineering (MSE), as it should, the area of metallic materials cannot be ignored. The onus is on the MSE course curriculum to include sufficient depth in Metallurgy for BTech graduates. Large industrial sectors that drive modern economy of a nation such India, are dependent up on structural materials – both metallic and non-metallic. All of mobility – automotive, railways, aircrafts, and the future VTOLs and Hyperloops – is heavily dependent up on use of the appropriate structural materials. These include steels, aluminium, titatnium and composites. Same is the case with defence, marine and oil & gas sectors. I strongly suggest addition of structural materials in the curriculum.

2. While you have a stream on Clean Energy & Energy Materials, I suggest you add the subjects of carbon capture and utilization and generation and use of hydrogen in metallurgical processes as a course in an appropriate form. If India has to attain its net carbon zero target, then successive generations of students must graduate well-versed in the modern technologies for deep decarbonization of the metallurgical processes and the usage sectors.

3. Biomaterials is another area that is missing in the course curriculum. You may have deliberately decided to not include this area. In that case, it will be prudent to mention so.

I trust this helps. With best regards.

Bhattacharjee

Response to the comments Dr Debashish Bhattacharjee:

Dr. Debashish appreciated the proposal with emphasis on more employment-friendly BTech course in Materials Science & Engineering. He has given two important suggestions to improve the course content. In this regard, we have proposed relevant courses in the revised proposal. Addition of Structural Materials course with great emphasis on steels and selected alloys might be bit more specialised towards metallurgy. Instead, we will cover the aspects under structural applications with good number of contents on metals, alloys, light weight and high strength materials and composites. We planned to cover these aspects in two courses, Materials Science for Engineers and Durability Behaviour of Materials. Since both of these courses already existing for B.Tech and M.Tech programs, the necessary changes will be incorporated in the respective courses.

The comment related with carbon capture and generation has been addressed by adding one elective course on "Green Processes and Decarbonization". For Biomaterials, since we have already B. Tech in Bio engineering at IIT Mandi, we didn't focus on this. However, a general course on Biomaterials and Biomedical Devices can be added as elective course as per the need.

Professor Krishanu Biswas
Dept of Materials Science and Engg.
Indian Institute of Technology, Kanpur

Thanks for writing me for a critical analysis of the proposal for the new dept. The proposal looks good. It is nicely prepared.
Few aspects:
1. You need to stress the use of computational tools in B.Tech curriculum and labs. You have added a compulsory course in Computational Materials Science. Add
few lab components.
2. 5 labs (Physical Met., Mechanical Met., Materials Processing, Extractive Met., and Functional Mater. Lab with experiments as well as projects will do good. You may 6th lab on Computational lab (simulations, design)
3. Compulsory course on Phase Transformation must contain Phase Diagrams too and Diffusion too
4. You may design the basic course on materials science properly. This is a key course for students to get interested.
5. Projects are good (MTP): these are to be designed properly across the breadth and depth of MSE
6. Teachers: you need to have at least 20 faculty to make this program successful.

Please don't hesitate to contact me for any other information. Recently, we have revamped our B.Tech curriculum for the next 10 years.

All the best
Krishanu Biswas

Response to the comments of Prof. Krishanu Biswas:

Overall, Prof. Krishanu Biswas appreciated the programme. Particularly he liked the lab components. His suggestions regarding a course on phase transformation will be given priority while developing the course contents inclusive of diffusion and related topics. As suggested, we have planned for Computational lab (simulations, design) with 2 credits as part of core course.

Prof. Nitya Nand Gosvami,
Department of Materials Science & Engineering,
Indian Institute of Technology-Delhi

Hi Viswanath, Overall, the proposal looks very good. I think the materials department in India should offer one course on metal extraction as there are major industries in the country and they have R&D as well where students will have job opportunities. I wonder if you may have included it in one of your electives? Another comment is to combine the Sensor Materials and Technologies along with Smart Materials and Actuators as they may have good overlap.

Response to the comments of Prof. Nitya Nand Gosvami,

Prof. Nityanand Gosvami appreciated the proposal. As suggested, the course on extraction and sensor materials has been added in discipline core and elective course respectively. While full core course on extraction is difficult due to credit limitations, the added course on "Extraction and Processing of Materials" will cover both materials extraction and processing.

Ranjith Ramadurai
Professor
Department of Materials Science and Metallurgical Engineering,
Indian Institute of Technology Hyderabad.

Dear Prof. Viswanath,

Thanks for sending me the curriculum of B.Tech "Materials Science and Engineering". Kindly find the comments / suggestions from my side. The comments are very generic without not being aware of the composition of the department and the senate rulings of IIT Mandi. So kindly ignore if some comments do not make any sense.

1. I see a course of structure and defects on solids - my suggestion would be having this course as "Physics of Solids" type of generic title will facilitate you to cover most of the fundamentals of solid-state physics including the currently proposed topic.
2. I do see a detailed 3 credit course on Quantum mechanics, I am not sure at the B.Tech level do they need a semester long Quantum Mechanics course, My suggestion would be couple the Applied Quantum mechanics with upto 13 to 15 lecture hours into the physics of solids course.

So Physics of solids will be one 3 credit course that includes applied quantum mechanics. For undergraduate level, I suppose this would suffice.

3. If you take up my previous suggestions then you have a leverage of 3 credits in which you can take the semiconductor materials and devices course as core course, which is currently in elective basket. This can also be in line with the manpower requirement of india semiconductor mission

4. If you do not agree with my suggestions of 1 and 2, at least you might think of changing the order of appearance of both the courses. QM can come earlier and Structure and defects with physics of solids content can follow later.

5. You dont seem to have a strong course on synthesis or solid-state chemistry, so my suggestion would be changing the Materials characterization course into Materials synthesis and characterization so some solid-state chemistry can be taught and characterization can be restricted to basic structural and microstructural characterizations, instead doing loads of techniques, which becomes ineffective in learning.

6. Course called Functional Materials can be converted to `Functional properties of materials', that can cover electronic, dielectric, magnetic, optical and intertwined properties of materials.

7. You might want to introduce thermodynamics of materials from the departmental aspect, since most of the common thermodynamics' courses do not cater to the aspects of materials thermodynamics. If there is a thermodynamics course on materials, basics of phase diagrams can be covered there and later the phase transformations course can be renamed as phase transformations and kinetics. that would facilitate you to cover the kinetics as well.

8. The Materials Processing course can be named as " Materials and Device processing" so some aspects of thin films and micro-nano fabrications can be covered.

9. solid Mechanics: - The solid mechanics course can be moved to earlier semesters more link within the first three semesters.

10. Though you have a course on computational materials science, you do not seem to have any numerical methods. I am of the assumption that computational materials science will touch upon some basics of numerical methods. Since you have a programming course in the earlier semesters, you might not need it, but numerical methods of 8-10 lecture hours might enhance effective learning of computational materials science. I am also assuming different length scales of computational materials engineering will be touched upon in this course.

11.PRT - product realization course can be moved to later semesters like 7th or 8th semester.

12. Elective Basket - Currently one of the baskets reads as "Quantum Materials and Devices" - My suggestion would be change that to "Low Dimensional Materials and Devices" so the micro and nano length scale courses included in that list are justified.

13. AI-Materials Genomics - Basket, though this basket sounds current and trendy, my suggestion would be name it as "Integrated computational materials engineering ICME" kind of topic' - this would facilitate you to include computational courses at various length scales and also facilitate teaching packages like comsol, abaqus, etc. some FEM courses and molecular

dynamics courses from other departments can also be included in the basket. So computational courses at various length scales are covered.
14. The smart and intelligent materials course can go into the energy and sustainability basket from the current quantum materials basket.

I also wish you and your team great success for the program.

Thanks and Regards
Ranjith

Response to the comments of Prof. Ranjith Ramadurai:

Thanks to Prof. Ranjith for his detailed comments on the B.Tech. curriculum. We agree with most of the comments and accordingly, the following changes are incorporated.

- As suggested, the "Materials Characterization" course is now replaced with "Materials Synthesis and Characterization."
- The course on "Functional Materials" is named as "Functional Properties of Materials" as the content will be mainly focussed on functional properties and their origin.
- The course on "Thermodynamics and Kinetics of Materials" has been added in the revised proposal.
- As suggested, Structure and Defects in Solids is modified to more general type of course "Physics of Solids" with the scope to cover basics of structure, symmetry, , reciprocal lattice, diffraction, X ray, electron and neutron diffraction, chemical bonding, defects, lattice dynamics, phonons, free electron theory, band theory of solids, metals, semiconductors, insulators, electrons, holes, electronic, optical properties and devices, magnetism, superconductivity etc.
- Quantum theory will be addressed on few of the specific topics in Physics of Solids and more detailed approaches and applications of quantum mechanics will be covered in separate course as it is relevant for current and emerging technologies.
- The elective baskets are also modified significantly. The major change is the addition of Integrated Computational Materials Engineering (ICME) in the place of AI and Materials Genomics as suggested by the expert.
- In addition, the elective basket "Quantum Materials and Technologies" also modified as "Quantum Materials and Semiconductor Devices" to make it relevant and broad. This will give more emphasis on the Semiconductor industry in line with the semiconductor mission program of India.

Ashish Garg

Professor and Head
Department of Sustainable Energy Engineering
Indian Institute of Technology Kanpur

It is good to know that you have thought about the materials UG program and have come up with a structure for it. I am also pleased to see that you have done a good SWOT analysis which allows you to see where you stand. Following is my feedback:

(i) Core: core component should be rather small, and only the fundamentals should be taught. That provides you with a lot of flexibility in running the program. In that sense, your core is well-designed by and large, with a few exceptions. I am pleased to see that your 6th-8th semesters are core free which is great; many older IITs are struggling with that.

- I would just suggest moving out engineering polymers, composites and functional materials to the electives. Or just one course on Functional Materials (perhaps 1-2 lectures per week) with a lab will do.

- Insert one course on thermodynamics and phase equilibria which is the backbone of materials science, do not confuse this with phase transformations. Phase transformation requires the teaching of phase transformation basics and their applications to solid-solid, liquid-solid and other phase transformations with emphasis also on microstructure development as well as some heat treatment. While in Thermodynamics, you need to focus on the thermodynamic basis of phase formation, their stability as a function of T, P and composition and then phase diagrams.

- Solid mechanics should ideally be institute core, not discipline core, as it is taught in several disciplines.
- If you are consciously deciding not to teach Extraction, then that is fine. Otherwise, a core course on principles of extraction and refining of materials is very important, telling a student where materials come from and how they are achieved in the state in which we use them.

- Regarding processing, taking a unit-process-based approach in the course would be good as it does not require you to teach separately for different material systems: for example; liquid, solid state and other thermal processing, Chemical and electrochemical processing, Mechanical (and thermomechanical) processing, you could perhaps merge some of them on one but keep the approach unit process based. There will of course be some overlaps.

(ii) Electives: I think you have far too many electives which seem very specific for UG or even Masters level. For instance, having a full course on sensors or smart materials or carbon materials will be too daunting. Instead, you might plan to have generic electives such as semiconductor materials and devices (that's a good choice) OR dielectrics and applications OR Energy Generation and Storage Materials and Devices with a focus only on Solar PV, Batteries,

Hydrogen and CCUS will do. Faculty members should ideally be moving beyond the teaching of very specialized teaching of their research area or materials, if they teach a little broad-based course, that also allows them to grow beyond their research.

(iii) I think a combined elective on Environmental Degradation and Recycling incl urban mining/sustainability would be good have as an elective. Just one will do, you don't need too many at the UG level.

(iv) Also, at some point, you need to think of having a course on the design and selection of materials, even a one-credit course will do but an introduction to this is necessary to make them think of why one uses a particular material for an application, what is the criteria for selection etc.

(v) Minors: I think you should build a roadmap of floating minors (year-wise vs faculty strength). The proposed minors and names are fine in principle except that I think four 3 credit courses will do instead of five. Having so many specialized electives will necessarily require floating several courses every semester and comes at the price of heavy teaching load. Also, depending on the number of teaching faculty, you could start with two and add the other two down the line.

An alternative model, I will propose is that have just two theory courses and, in addition, build a capstone project, starting from 3rd year, for a student who wants to do a minor in a particular area. The project could be equivalent to 10-15 credits and could be coupled with a good seminar presentation (maybe periodic), something similar to a comprehensive exam which should force a student to conduct self-study on a couple of topics and then be grilled by a committee. If this can be worked out, not only you reduce the number of courses, you will also provide hands-on experience and good presentation skills. However, it will require faculty members to be strict about implementation and learning objectives than just engaging them in their own research as a pair of hands.

-Also, some of the minor courses could be common among the minors.

(vi) Finally, I propose that the proportion of credits could be adjusted to something like 40%: Discipline and 60%: General Engg, Science Humanities etc. but that is to be determined by the Institute's philosophy.

1. Materials is research driven discipline, and it would be good to train students to research and education both. For industry absorption, trends suggest that manufacturing will have a rather weak attraction among the UG as long as other blue collared better paid jobs are available. If we can convince the students that their future in the core sector will be better after a few years than in software/consulting, then the trend may reverse, however this has not happened. I have a few students who have gone on to work in companies such as applied materials even after BT or MT which is encouraging. Unfortunately, this is something that has remained a problem worldwide at the UG level.

2. Although not relevant to the present document, at the PG level, USA gets top of the students from all over the world and most of these get absorbed in various industries with good salaries. PhD in Materials Science is a good option for those who don't want to do pure science and there is a possibility of good employment. However, India's intake in PG is rather weak and we need to do a lot to train them, even in the US, students have to take a considerable number of courses. Most Indian institutes, most IITs included, have not shown the appetite for good quality PG teaching and strong coursework to build a solid foundation. IIT Mandi could give it a thought.

If you have any questions, let me know, I will be happy to discuss.

Thanks
Ashish

Response to the comments of Prof. Ashish:

In brief, Prof. Ashish praised the overall program and suggested several things to consider for improvement. He has suggested focusing on fundamental courses in core and keeping the applications and allied subjects in elective baskets.

He also has given couple of suggestions on discipline core courses. His main suggestions are to incorporate the courses such as thermodynamics, extraction and processing etc. Now, we have added separate course on Thermodynamics and Kinetics of Materials in addition to Phase Transition as per his suggestion. We also added the extraction in materials processing course.

The applied courses such as polymers and composites are removed from the core course. At the same time, it is important to cover the subject of polymers, composites and structural materials to provide the broad background to students. Accordingly, these contents will be added in the IC course "Materials Science for Engineers". In addition, the materials selection and design aspects will be also covered by revising the course content of IC-241- Materials Science for Engineers.

Prof. Ashish has also made a remark on electives to make them generic type of course instead of too specialized courses at UG level. Indeed, it is a very good suggestion and the same is implemented in the revised curriculum and further necessary action will be taken during the development of elective courses.

Moreover, he suggested building a capstone project starting from 3rd year. In this regard, we have already proposed UG research program (B.Tech. Honors in Research and Development). The learning objectives will be worked out with inclusion of research, presentations etc.

Prof. Prita Pant

Dept. of Metallurgical Engineering and Materials Science, IIT Bombay

The proposal looks quite good. I think this will be a popular UG program. Specific inputs:

1. The degree should be BTech in Materials Science and Engineering and not "Material Science..."

2. Is Solid state diffusion covered as part of any of the courses? Transport Phenomena?

3. Similarly, are topics from Kinetics covered along with Phase Transformation?

4. We recently had a long debate on Characterization course as part of the UG program and felt that if we try to cover all techniques - optical and electron microscopy, diffraction, spectroscopy, thermal characterization, and then electronic properties, we would not be able to do justice to any of them. We are now contemplating doing a joint lab + lecture for structural characterization, and take some of the topics to other labs.

5. Similar concerns for Materials Processing - how many topics can be covered and to what depth.

6. Are there lab courses accompanying Structures and Mech behavior theory courses.

7. Lastly, I am not sure if it is feasible to insist on a paper or patent as a requirement for B.Tech. Honours. That may dissuade students or guides from trying new things out. Maybe some additional recognition can be given to students who actually publish a paper - it could be either academic or support for attending a conference or monetary reward - but I do not think a publication should be an academic requirement at the Bachelors level.

Prita Pant

Response to the comments of Prof. Prita Pant:

Prof. Prita Pant mentioned that the proposed program is quite good and will be popular. She has also asked few questions and provides suggestions for further improvement. In brief, our revised proposal covers the following aspects in response to the received comments of Prof. Prita Pant.

1. Yes, the degree will be B.Tech. Materials Science and Engineering.

2. The basics of solid-state diffusion will be covered along with defects in IC course "Materials Science for Engineers". More details will be covered in "Transport Phenomena". We will ensure the same during the complete course development.

3. We received similar comments and are now planning to introduce a separate core course on "Thermodynamics and Kinetics of Materials" in addition to "Phase Transition". Hence more emphasis will be given to this important subject.

4. We also had the same discussion and are now planning to solve the issue by dual approach. In "Physics of Solids" and "Materials Science for Engineers" we will try to cover more on Structure

along with diffraction, XRD and electron microscopy. On the contrary, we expose students to many different methods including XRD, electron microscopy in Materials Synthesis and Characterization course along with laboratory sessions. This course will be a 4-credit course (2 for theory and 2 for experiments) and will be taught together covering both theory and experiment on a weekly basis.

5. Yes, it is a good point and challenging task as we may need to cover around 10 experiments/topics for metals, ceramics, and polymers. We will ensure more lectures on basic processing like heat treatment. On the other hand, broad exposure on topics like, laser processing, plasma sintering, welding and device process steps like lithography also will be covered. Since we do not have separate courses on extractive metallurgy, we may cover extraction as well. More refinement will be needed as we develop the full course content.

6. At present, we are planning for a total of 6 labs (6 X 2 = 12 credits). Out of six, Materials characterization and Materials processing courses will be taught by combining theory and experiments. Other labs, we are planning to keep it separate. Based on your suggestion, we could teach mechanical behavior by combining the "Mechanical Behavior" course along with "Materials Testing". We will explore this aspect further.

7. Yes, it cannot be made as mandatory but students may be encouraged to work towards publications/patents with some incentives. We will improve the clarity on this aspect for sure.

In summary, the received comments from total of 9 external experts are much appreciated and used for revising the proposed B.Tech. curriculum to maximum possible extent within the credit structure of UG programs at IIT Mandi. We submit the final proposal of B.Tech. Materials Science and Engineering to the Senate for further consideration and approval.

Programme Proposal Form

Name of the New Proposed Program BTech in General Engineering (Applied Engineering)

I. General Information:

Name (s) of prosper schools/centres:

School of Mechanical and Materials Engineering.

II. Program Description:

A. Provide a justification/rationale for the program. How does the program relate to the mission of the IIT Mandi?

Imbibe the skillset that is transferable to most industries and helps towards attaining an inclusive and sustainable society.

B. SWOT analysis of the program

Strength:

- Faculty specialization in various fields.
- Experiential learning for the students.
- Focus on applied courses and labs
- Choice of a variety of major and minor programs
- Compulsory internship (business/research)

Weakness

Since the program is focused on applied learning the focus on the detailed research on any specific topic would be less.

Threats

- Competition with 1st gen IIT's
- Considering it is a new program, attracting the best quality students would be a challenge, initially only.

Opportunities

- Academic autonomy.
- Availability of alumni network.
- Industry focus.

C. Justification with respect to New National Education Policy (NEP) mandates

The NEP requires courses to be multidisciplinary, the proposed course perfectly fits

into this aim of NEP by providing a multifaceted education that suits most of the industries and helps create a skilled workforce. Additionally, the course will offer multiple entries and exit opportunities with programs like diplomas, certificates, and degrees, which is in line with NEP.

D. Provide a mission statement for the program. Include educational and learning objectives

To provide an academia-industry conducive ecosystem to produce a skilled workforce for meeting global challenges.

E. Credit Structure of the program

Symbol	Course Type	Current credits	Proposed credits
DC	Discipline core	41	24 (33)
DE	Discipline elective	24	32
FE	Free elective	24	24
HSS	Humanities and Social Science Course	12	12
IC	Institute Core	46	46
IKS	Indian knowledge system	1	1
ISTP	Interactive Socio-Technical Practicum	4	4
MTP 1	Major Technical project 1	3	3
MTP 2	Major Technical project 2	5	5
	Internship/Research in the discipline		9
		160	160

The complete list of semester-wise courses is provided in Appendix-A

F. List of courses proposed

Course Name	Credits
Product design and product development	3
Engineering and Society	3
Engineering Computation	3
Energy Engineering	3

Sustainable Development	3
Scientific Communication	3
Engineering Economics	3
Total	21

Labs	**Credits**
Advanced engineering diagnostic	1
Product development	1
Mechanical Workshop	1

Symbol	**Course Type**	**Proposed credits**
DE	Discipline elective	32
MTP 1	Major Technical project	8
	Internship/Research in discipline	9
		49

G. Provide a list of any current courses that would be cross-listed with the program:

The courses from other disciplines will be selected based on the major and minor selected by the students, following the below strategy.

No	**Majors**	**Max allowed %**
1	Civil Engineering	20
2	Computer Science and Engineering	20
3	Electrical Engineering	20
4	Mechanical Engineering	20
5	Data Science and Engineering	20
6	Engineering Physics	20
7	Bio-Engineering	20

The maximum number of students selected in major programs will be limited to 20% of the total class strength

H. What, if any, new courses will be required for the program? A separate course proposal is required for each new required course.
The new course required for the program are listed in Section F

I. Provide a sample academic plan for students completing the academic program being proposed.

The students can go to industries as well as for higher education.

J. If established at other institutions, please submit sample programs from those institutions.

IIT Hyderabad - Engineering Science (https://es.iith.ac.in/index.html)
Oxford University - Engineering Sciences (https://www.ox.ac.uk/admissions/undergraduate/courses/course-listing/engineering-science)
Staffordshire University (https://www.staffs.ac.uk/course/general-engineering-beng)
Nottingham Trent University (https://www.ntu.ac.uk/course/mansfield/ug/hnc-general-engineering)
University of Arizona - Engineering Management (https://sie.engineering.arizona.edu/undergrad-programs/degrees)

1. In what ways is this proposal consistent with those programs?

The programme is offered in conjunction with other programmes, with the core idea of providing hands-on experience in various fields of engineering and then allowing students to choose an area of specialisation.

2. In what ways is this proposal different from those programs? Please explain those differences.

- Industry-focused curriculum
- Compulsory internship (business/research)
- Experiential learning

III. Faculty and Governance:

Provide a list of the faculty available to teach courses for this program.

1. Satvasheel R Powar
2. Mrityunjay Doddamani
3. Gajendra Singh
4. Atul Dhar
5. Surya Prakash Upadhyay

In case of interdisciplinary program, mention governances and execution mechanism of the programme:

_____

_____

_____

IV. Student interest:

What measures of student interest in the program are there? How/why are the proposers convinced that students would want to take this program of study? (Attach Career and Placement Cell recommendation or any other)

Topics such as Applied Engineering, Engineering Diagnostics are included in General Engineering. General Engineering graduates can apply engineering concepts to a variety of technological challenges and develop conceptual designs into operational systems. Additionally students can take part in major and minor programmes in the all other available degree programmes such as Civil, Mechanical, Electrical, Computer Science, etc. The interdiscplinary handson skills are very much appreciated by the engineering students and employers.

Resources:

Additional requirements of laboratory space with justification (name of the labs)

1. Advanced engineering diagnostic
2. Product Development
3. _____
4. _____

Additional requirements of laboratory fund (recurring and non-recurring) with justification (name of the labs)

1. Advanced Engineering Diagnostics
2. Product Development
3. _____

Additional requirements of faculty and non-teaching staff (Numbers and justification)

1. _____
2. _____
3. _____
4. _____

5. _____

V. Origin and development of the proposal:

- Please mention name for faculty involve in developing this proposal.
  1. Satvasheel R Powar
  2. Mrityunjay Doddamani
  3. Gajendra Singh
  4. _____
  5. _____
- Details of external industry experts and their recommendations (please include their evaluation)
  1. _____
  2. _____
  3. _____
  4. _____
  5. _____
- Details of external academia experts and their recommendations (please include their evaluation):
  1. _____
  2. _____
  3. _____
  4. _____
  5. _____
- Proposers faculty name and their signatures :

Name of Faculty members	**Signatures**
1. Satvasheel R Powar	
2. Mrityunjay Doddamani	
3. Gajendra Singh	
4.	

Recommendations of Chairperson of School/ Centre

Signature with Date:

Dean (Students) recommendations on availability of hostels and other requirements

Signature with Date:

Associate Dean (Courses) recommendation on class rooms availability and other academic infrastructure requirements

Signature with Date:

Dean Finance recommendation on financial aspects (if any)

Signature with Date:

Dean Academics recommendations:

Recommended/Not Recommended

Signature with Date:

Please enclose additional information if any.

Appendix-A

Detailed course structure

B.Tech. (General Engineering) – 1st Semester

S.No	Code	Course Name	Lecture	Tutorial	Practical	Credit
1	IC110	Engineering Mathematics – 1	2.5	0.5	0	3
2	IC140	Engineering Graphics for Design	2	0	3	4
3	IC152	Introduction to Python and Data Science	3	0	2	4
4	ICXXX	basket – 1	2.5/3	0.5/0	0	4
5	HSXXX	HSS Course	3	0	0	3
6	YYXXX	Ikshma Course	3	0	0	3
		Total Credits				21

B.Tech. (General Engineering) – 2nd Semester

S.No	Code	Course Name	Lecture	Tutorial	Practical	Credit
1	IC111	Engineering Mathematics - 2	2.5	0.5	0	3
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	basket-2	2.5/3	0.5/0	0	3
6	ICXXX	Foundations of Design Practicum	1	0	6	4
7	IC221P	Physics Practicum	0	0	3	2
		Total Credits				21

B.Tech. (General 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		Sustainable Development	3	0	0	3
4		Engineering and Society	3	0	0	3
5		Engineering Economics	3	0	0	3
6	IC		3	0	0	3
7	HSXXX	HSS Course				3
		Total Credits				21

B.Tech. (General Engineering) – 4th Semester

S.No	Code	Course Name	Lecture	Tutorial	Practical	Credit
1		Energy Engineering	3	0	2	4
2		Engineering computation	3	0	0	3
3		Scientific Communication	3	0	0	3
4		Product design and product development	3	0	2	4
5	HSXXX	HSS Course				3
6	IC	Reverse engineering	0	0	2	1
7	FE-1	Free Elective				3
		Total Credits				21

B.Tech. (General Engineering) – 5th Semester

S.No	Code	Course Name	Lecture	Tutorial	Practical	Credit
1		Discipline Elective	3	0	0	3
2		Discipline Elective	3	0	0	3
3		Discipline Elective	3	0	0	3
4		Free Elective	3	0	0	3
5		Free Elective	3	0	0	3

6		Free Elective	3	0	0	3
7	HSXXX	HSS Course	3	0	0	3
		Total Credits				21

B.Tech. (General Engineering) – 6th Semester

S.No	Code	Course Name	Lecture	Tutorial	Practical	Credit
1		Discipline Elective	3	0	0	3
2		Discipline Elective	3	0	0	3
3		Discipline Elective	3	0	0	3
4		Free Elective	3	0	0	3
5		Free Elective	3	0	0	3
6		ISTP	0	0	4	4
		Total Credits				19

B.Tech. (General Engineering) – 7th Semester

S.No	Code	Course Name	Lecture	Tutorial	Practical	Credit
1		Discipline Elective / Free Elective				3
2		Discipline Elective / Free Elective				3
3		Discipline Elective / Free Elective				3
4		Free Elective				3
5		Free Elective				3
6	MTP-1	MTP-1				3
		Total Credits				18

B.Tech. (General Engineering) – 8th Semester

S.No	Code	Course Name	Lecture	Tutorial	Practical	Credit
1		Discipline Elective / Free Elective				3
2						
3		Inernship				10
4		MTP-2				5
		Total Credits				18

Program Proposal Form

Name of the New Proposed Program: 4-Year BS with optional 1-Year MS (BS-MS) in Chemical Sciences

I. General Information:

Name (s) of prospering schools/centers **School of Chemical Sciences** (in case of an interdisciplinary program, please mention all schools/center's names)

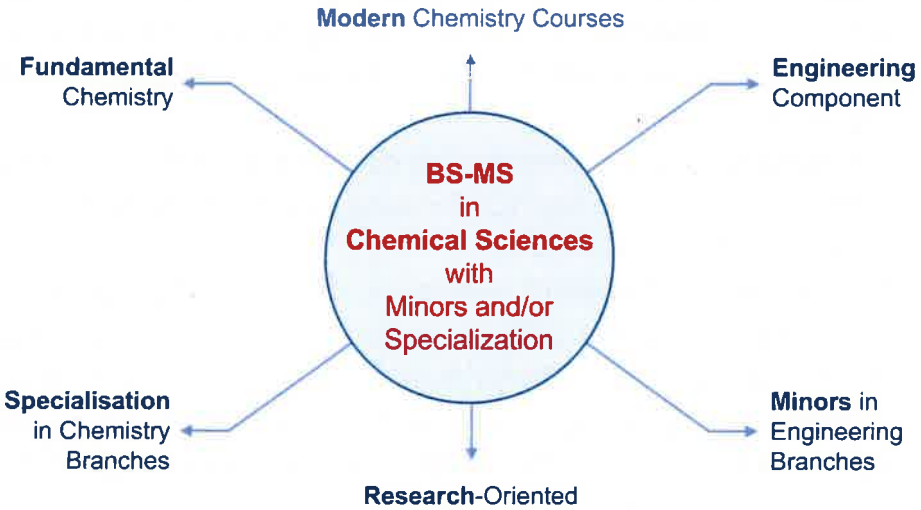
II. Program Description:

A. Provide a justification/rationale for the program. How does the program relate to the mission of the IIT Mandi?

The discipline of Chemical Sciences as an integral part of basic sciences serves as the basis of critical developments for value-added chemicals, pharmaceuticals, novel materials, understanding biological processes, and establishing the theoretical basis of natural phenomena. Therefore, the BS-MS program in Chemical Sciences will create a perfect harmony between chemistry and engineering branches by bridging the gap between chemical, physical, mathematical, computational, data, and engineering sciences. This will create a broad knowledge base through fundamental and applied sciences and engineering for young graduates and produce trained professionals capable of leading endeavors toward innovative product and process development for the Himalayan region and national needs in general. Importantly, with the versatility of the curriculum, the graduates will be exposed to research and development at a very early stage of their education to pursue industrial as well as academic goals. Thus, the program's major objectives align very well with IIT Mandi's mission.

B. SWOT analysis of the program

Strength:



Weakness:

- Slightly more emphasis has been given to the engineering courses, which may lead to the dilution of the core Chemistry.

- Currently, the curriculum doesn't have any mandatory industry internship program.

Opportunities:

- The holistic nature of the program will offer the BS-MS Chemistry graduates to have job opportunities in a wide range of industries.
- The research-intensive nature of the program will train the students to pursue an academic career (Ph.D.) in renowned national and international institutes.
- BS-MS Chemistry graduates will also have job opportunities in the technology industry.

Threats:

- As a considerable component of the curriculum is based on engineering subjects, the students who wish to pursue their career in research may opt for IISER's BS-MS (which has a major focus on science subjects) over this program.
- As there will be an option for branch change, it will result in a decrease in student strength in subsequent years.

C. Justification with respect to New National Education Policy (NEP) mandates

One of the NEP mandates is to provide a more flexible and holistic approach to education, focusing on foundational learning, critical thinking, and life skills. The BS-MS program in Chemical Sciences involves a perfect ratio of fundamental chemistry, specialized chemistry, basic engineering, humanities, hands-on, and research projects, which provide a solid foundation of a holistic and interdisciplinary learning platform. In addition, the minors in engineering branches and specialization in advanced chemistry branches with research experience provide a highly flexible learning environment.

The versatile range of engineering components in the proposed BS-MS program is perfectly aligned with the NEP focusing on using technology in education to make it more accessible and effective.

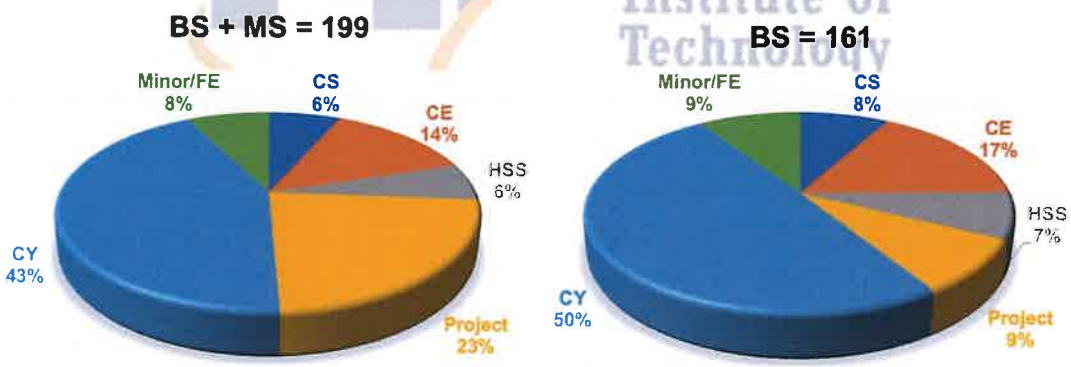
A large amount of research component in the BS-MS program aligns with one of the key objectives of the NEP to make India a global knowledge superpower by promoting research and innovation. In addition, the BS-MS program will encourage graduates to pursue higher education, which fits the NEP mandate of increasing the gross enrolment ratio (GER) in higher education to 50% by 2035.

D. Provide a mission statement for the program. Include educational and learning objectives

The 5-year BS-MS program in Chemical Sciences is designed to prepare graduates with a strong foundation in fundamental Chemistry along with Engineering for today's research and technology-driven world. The program creates a perfect harmony between chemistry and engineering branches by bridging the gap between chemical, physical, mathematical, computational, data, and engineering sciences. Particularly, owing to the "true" cross-disciplinary nature of the program, it can help advance the knowledge ranging from atomic-level understating of the chemical and biochemical phenomena to designing and developing new molecules, materials, and devices. As the barrier between basic sciences and engineering is fast disappearing with modern innovations and their applications, the BS-MS program in Chemical Sciences can perfectly inculcate the young minds in academia to develop and deploy chemistry-based technologies for the modern world.

The major objective of this program is to train the graduates with fundamental concepts of both Chemistry and Engineering, thereby, equipping them for taking up diverse roles in industry and academia. The program particularly aims at training young minds to creatively think about research and innovation at a very early stage through a diverse range of hands-on projects. The perfect fusion of chemistry and engineering along with specializations and minors in different branches is the goal that will prepare the students for industry and academia and motivate them toward research and innovation.

E. Credit Structure of the program



The overall credit distribution is tabulated below.

Division	Sub-Division	Credit
Institute Core (IC)	IC Compulsory	37
	IC Basket	6
	HSS	9
	IKS	3
Discipline (CY)	Discipline Core	62
	Discipline Elective	15

Electives (E) + Projects	Free Electives	15
	Project	14
BS Total		**161**
MS Component	**Discipline Elective**	6
	MS Project	32
BS-MS Total		**199**

F. List of courses proposed (Course names are tentative and subject to change)
1. CY1XX: General Introduction to Chemistry
2. CY2XX: Principles and Theories of Physical Chemistry
3. CY2XX: Physical Chemistry Laboratory
4. CY2XX: Principles of Organic Chemistry
5. CY2XX: Organic Chemistry Laboratory
6. CY2XX: Introduction to Inorganic Chemistry
7. CY2XX: Inorganic Chemistry Laboratory
8. CY3XX: Fundamental Analytical Chemistry
9. CY3XX: Introduction to Quantum Chemistry and Molecular Spectroscopy
10. CY4XX: Basic Computer Programming, Computation, and Data Analysis (E)
11. CY4XX: Applied Polymer and Materials Chemistry (E)
12. CY5XX: Stereochemistry and Asymmetric Synthesis

G. Provide a list of any current courses that would be cross-listed with the program:
1. IC1XX: Calculus
2. IC1XX: Linear Algebra
3. IC1XX: Graphics for Design
4. IC1XX: Computing and Data Science
5. IC1XX: Complex Variables and Vector Calculus
6. IC161: Applied Electronics
7. IC161P: Applied Electronics Lab
8. IC1XX: Data Science II
9. ICXXX: Foundations of Design Practicum
10. IC222P: Physics Practicum
11. ICXXX: Data Science III
12. IC201P: Design Practicum
13. ICXXX: ODE & Integral Transforms

H. What, if any, new courses will be required for the program? A separate course proposal is required for each new required course.

The new courses proposed in the "List of courses proposed" in Section F will be required. The detailed course curriculum for the courses is attached as a separate document.

I. Provide a sample academic plan for students completing the academic program being proposed.

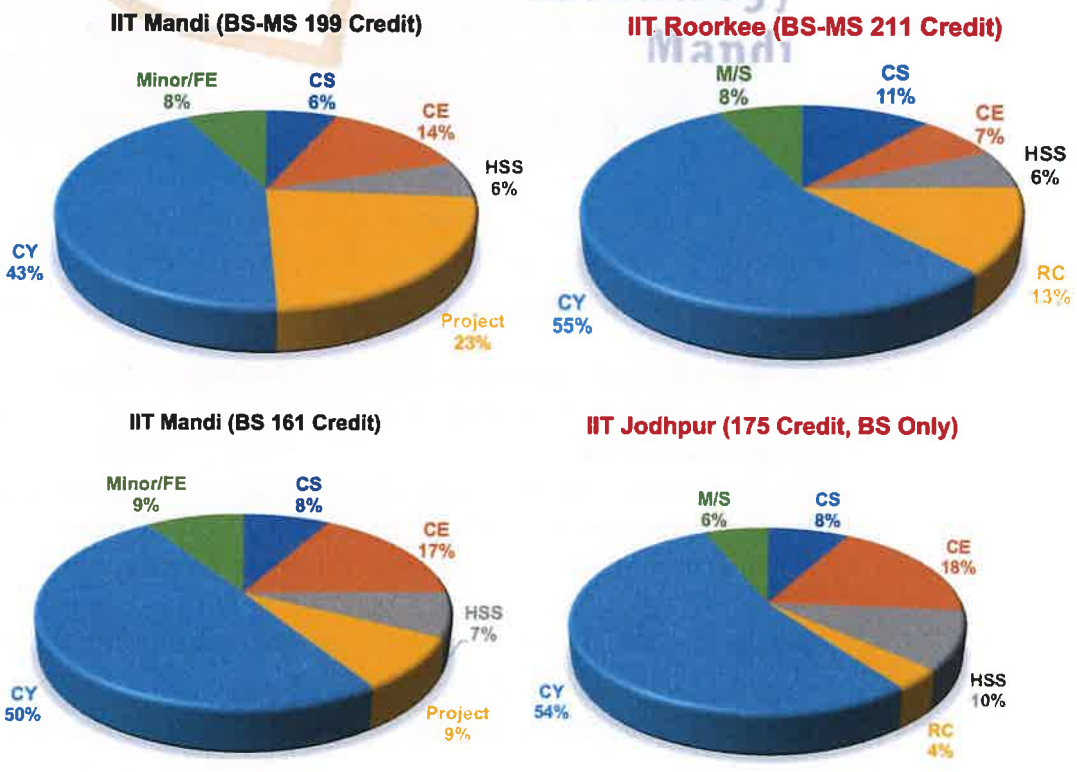
A sample academic plan for students detailing the program description, admission procedure, credit structure, and graduation requirements is attached.

J. If established at other institutions, please submit sample programs from those institutions.

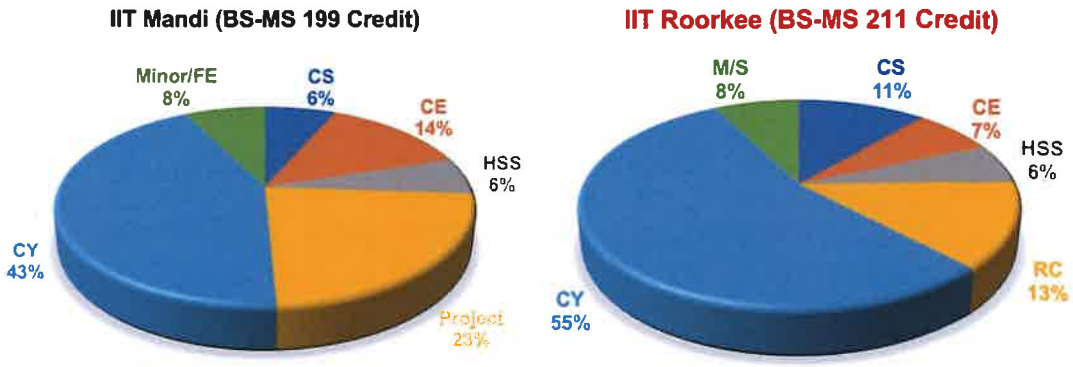
A 5-year BS-MS program in Chemical Sciences/Chemistry is established at IIT Bombay, IIT Kanpur, and IIT Roorkee, and a 4-year BS program is established at IIT Jodhpur. Available program details from IITB, IITR, and IITJ are attached along with this document.

1. In what ways is this proposal consistent with those programs?

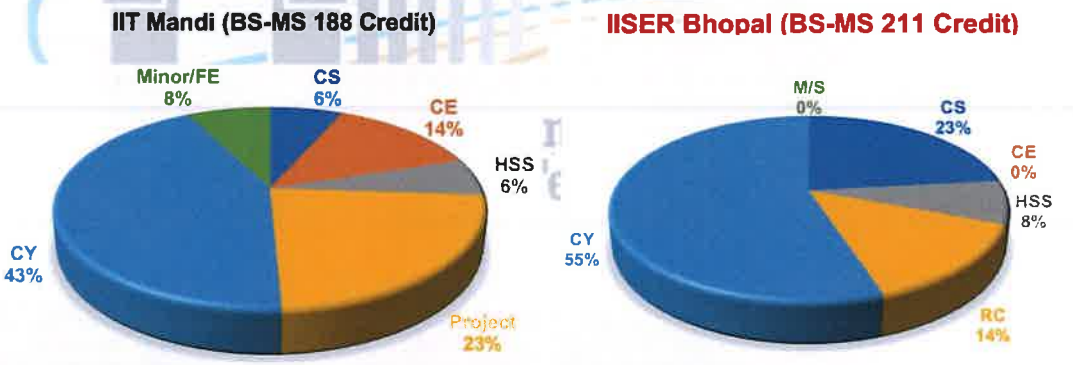
The proposal is consistent with the IITR and IITJ program structure in terms of chemistry core (CY), common science (CS), common engineering (CE), humanities (HSS), and free electives (FE) components.



2. In what ways is this proposal different from those programs? Please explain those differences.



The proposed BS-MS program has more research components compared to IITR and IITJ. Moreover, as compared with the traditional BS-MS program offered at one of the IISERs (IISER Bhopal), the IIT Mandi BS-MS program has more research components.



In general, the BS-MS program offers specialization in chemistry branches, minors in engineering and humanities branches, and is highly research-oriented, which makes the program one of its kind. Particularly, it offers,

- Specialization in major chemistry branches, organic, inorganic, physical, and material chemistry through discipline elective courses in the 3rd and 4th year of BS.
- Minors in different branches include Computer Science Engineering, Communication Engineering, Electronics Engineering, Measurement and Instrumentation, Management, German Language, etc.

Due to the research-oriented nature of the program, the graduates get good exposure to research in the desired area as early as in their 4th year of the BS program. In addition, the 5th year of MS is primarily research-focused with

specialized theory courses. Thus, the program presents a unique opportunity for graduates to pursue a research career just after completing the BS.

III. **Faculty and Governance:**

Provide a list of the faculty available to teach courses for this program.

Following is the list of faculties available at the School of Chemical Sciences to teach the proposed courses of the program.

1. Dr. Aditi Halder
2. Dr. Amit B. Pawar
3. Dr. Aniruddha Chakraborty
4. Dr. Bhaskar Mondal
5. Prof. Chayan Kanti Nandi
6. Dr. Garima Agrawal
7. Dr. Moupriya Das
8. Prof. Pradeep C. Parameswaran
9. Prof. Prem Felix Siril
10. Prof. Subrata Ghosh
11. Dr. Venkata Krishnan

In case of interdisciplinary program, mention governances and execution mechanism of the programme:

_____

_____

_____

IV. Student interest:

What measures of student interest in the program are there? How/why are the proposers convinced that students would want to take this program of study? (Attach Career and Placement Cell recommendation or any other)

The discipline of Chemical Sciences as an integral part of basic sciences serves as the basis of critical developments for value-added chemicals, pharmaceuticals, novel materials, understanding biological processes, and establishing the theoretical basis of natural phenomena. The 5-year BS-MS program in Chemical Sciences is designed to prepare graduates with a strong foundation in fundamental Chemistry along with Engineering for today's research and technology-driven world.

The BS-MS Chemical Sciences program graduates will have placement opportunities in various chemical, pharmaceutical, and technology industries. In addition, after completing the MS, they will have the opportunity to pursue a research career in a specialized field.

The following is a list of some of the potential employers for the BS-MS Chemistry Graduates

Chemical and Pharmaceutical Industry:

- Syngene International Ltd.
- Dr. Reddy's Laboratories
- BASF India Ltd.
- Bayer India
- Aurigene Pharmaceutical Services Ltd.
- Sun Pharmaceutical Industries Ltd.
- Ranbaxy Laboratories Ltd.
- Lupin Ltd.
- Hindustan Unilever

Public Sector Undertakings:

- Oil and Natural Gas Corporation Limited (ONGC)
- National Thermal Power Corporation (NTPC)
- Bharat Electronics Limited (BEL)
- Bharat Petroleum Corporation Limited (BPCL)
- Hindustan Petroleum Corporation Limited (HPCL)
- Indian Oil Corporation Limited (IOCL)

Resources:
Additional requirements of laboratory space with justification (name of the labs)

Dedicated laboratory space for the BS-MS Chemical Sciences will be required to conduct all planned laboratory courses smoothly.

1. BS-MS Chemical Science Lab
2. _____
3. _____
4. _____
5. _____

Additional requirements of laboratory fund (recurring and non-recurring) with justification (name of the labs)

An estimated laboratory fund of 20 Lakhs (recurring: 10 lakhs + non-recurring: 10 lakhs) will be required per academic year for the laboratory courses.

1. BS-MS Chemical Science Lab (20 lakhs)
2. _____
3. _____
4. _____
5. _____

Additional requirements of faculty and non-teaching staff (Numbers and justification)

At least 10 faculty members for teaching the fundamental and applied chemistry courses and two laboratory assistants for running and maintaining the laboratory and one office assistant will be required.

1. Faculty (10)
2. Laboratory Assistant (02)
3. Office Attendant (01)
4. _____
5. _____

V. Origin and development of the proposal:

- Please mention the names of the faculty involved in developing this proposal.

  A BS-MS program proposal committee was formed with the following members.

  1. Dr. Bhaskar Mondal (Committee Chair)
  2. Prof. Chayan K. Nandi (Member)
  3. Prof. Subrata Ghosh (Member)
  4. Dr. Garima Agrawal (Member)
  5. Dr. Amit B. Pawar (Member)

- Details of external industry experts and their recommendations (please include their evaluation)

  1. Dr. Harish Shinde (BASF India Ltd.)
  2. Dr. Sathya Shanker (Syngene International Ltd.)
  3. Dr. Archan Dey (Dr. Reddy's Laboratories)
  4. Dr. Amalesh Roy (Aurigene Pharmaceutical Services Ltd.)

- Details of external academia experts and their recommendations (please include their evaluation):

  1. Prof. Anindya Datta (IIT Bombay)
  2. Prof. Pratik Sen (IIT Kanpur)
  3. Prof. Kaushik Ghosh (IIT Roorkee)

  **Comments are yet to be received. Comments received so far along with the response are attached as a separate document.*

- Proposer's faculty name and their signatures:

Name of Faculty members	Signatures
1. Bhaskar Mondal	Bhaskar Mondal
2. Chayan K. Nandi	e-mail approval attached
3. Subrata Ghosh	e-mail approval attached
4. Garima Agrawal	e-mail approval attached
5. Amit B. Pawar	e-mail approval attached

Recommendations of Chairperson of School/ Centre

Signature with Date:

Dean (Students) recommendations on availability of hostels and other requirements

Signature with Date:

Associate Dean (Courses) recommendation on classrooms availability and other academic infrastructure requirements

Signature with Date:

Dean Finance recommendation on financial aspects (if any)

Signature with Date:

Dean Academics recommendations:

Recommended/Not Recommended

Signature with Date:

Please enclose additional information if any.

Academic Plan

for

4-Year Bachelor (BS) with Optional 1-Year Masters (MS)

in

Chemical Sciences

with

Specialization in

Organic, Inorganic, Physical, and Material Chemistry and

Minor in

(Computer Science Engineering, Communication Engineering, Management, German Language, etc.)

School of Chemical Sciences (SCS)

Indian Institute of Technology Mandi

Mandi, HP-175075

Table of Contents

1. Introduction

1.1. Preamble of the program

The discipline of Chemical Sciences as an integral part of basic sciences serves as the basis of critical developments for value-added chemicals, pharmaceuticals, novel materials, understanding biological processes, and establishing the theoretical basis of natural phenomena. The 4-year BS with an optional 1-year MS program (BS-MS) in Chemical Sciences is designed to prepare graduates with a strong foundation in fundamental Chemistry along with Engineering for today's research and technology-driven world. The program creates a perfect harmony between chemistry and engineering branches by bridging the gap between chemical, physical, mathematical, computational, data, and engineering sciences. Particularly, owing to the "true" cross-disciplinary nature of the program, it can help advance the knowledge ranging from atomic-level understating of the chemical and biochemical phenomena to designing and developing new molecules, materials, and devices. As the barrier between basic sciences and engineering is fast disappearing with modern innovations and their applications, the BS-MS program in Chemical Sciences can perfectly inculcate the young minds in academia to develop and deploy chemistry-based technologies for the modern world.

1.2. Objective of the Program

The major objective of this program is to train the graduates with fundamental concepts of both Chemistry and Engineering, thereby, equipping them for taking up diverse roles in industry and academia. The program particularly aims at training young minds to creatively think about research and innovation at a very early stage through a diverse range of hands-on projects. The perfect fusion of chemistry and engineering along with specializations and minors in different branches is the goal that will prepare the students for industry and academia and motivate them toward research and innovation.

1.3. Uniqueness of the Program

The BS-MS program offers specialization in chemistry branches, minors in engineering and humanities branches, and is highly research-oriented, which makes the program one of its kind. Particularly, it offers,

- Specialization in major chemistry branches, organic, inorganic, physical, and material chemistry through discipline elective courses in the 3rd and 4th year of BS.
- Minors in different branches include Computer Science Engineering, Communication Engineering, Electronics Engineering, Measurement and Instrumentation, Management, German Language, etc.

Due to the research-oriented nature of the program, the graduates get good exposure to research in the desired area as early as in their 4th year of the BS program. In addition, the 5th year of MS is primarily research-focused with specialized theory courses. Thus, the program presents a unique opportunity for graduates to pursue a research career just after completing the BS.

1.5. Placement Prospects

The BS-MS Chemical Sciences program graduates will have placement opportunities in various chemical, pharmaceutical, and technology industries. In addition, after completing the MS, they will have the opportunity to pursue a research career in a specialized field.

2. Details of the Program

2.1. Admission procedure

The admission has been primarily planned through Joint Entrance (Advanced) Examination.

2.2. Intake strength

To be updated later

2.3. Duration

BS: 4 years, 8 semesters

BS-MS: 5 years, 10 semesters

2.4. Credits to be earned

A minimum of 161 credits needs to be earned for the BS degree and a minimum of 199 credits needs to be earned for the BS-MS dual degree.

2.5. Branch change policy

The existing branch change policy at IIT Mandi will be applicable to students enrolled in the BS-MS Chemical Science program.

2.6. Exit option

There will be an exit option available after the 4th year completing eight semesters for a BS degree in Chemical Sciences.

2.7. Graduation requirements

A student can complete the BS degree in Chemical Science by earning a total of 161 credits comprising,

a. 55 Credits of Institute Core (IC)
b. 62 Credits of Discipline Core
c. 15 Credits of Discipline Elective
d. 15 Credits of Free Elective
e. 14 Credits of Research Lab and Presentation

In addition, a student can complete the BS-MS dual degree in Chemical Sciences on earning an additional 38 credits comprising of,

a. 6 Credits of Discipline Elective
b. 32 Credits of MS Project

To avail of one of the following specializations in organic, inorganic, physical, and material chemistry, a minimum of 12 credits of elective courses in the required area and a CGPA of 7.0 must be completed.

To successfully complete a minor, a student needs to take at least 9 credits with a CGPA of 7.0 out of the courses defined in the corresponding minor basket.

3. Overview of the Program and Credit Distribution

3.1. Overall credit distribution

The overall credit distribution is tabulated below.

Division	Sub-Division	Credit
Institute Core (IC)	IC Compulsory	37
	IC Basket	6
	HSS	9
	IKS	3
Discipline (CY)	Discipline Core	62
	Discipline Elective	15
Electives (E) + Projects	Free Electives	15
	Project	14
BS Total		**161**
MS Component	**Discipline Elective**	6
	MS Project	32
BS-MS Total		**199**

3.2. Semester-wise course distribution**

The semester-wise credit distribution is tabulated below

1st-Year (as per the Institute's B.Tech. curriculum)

Semester-I		Semester-II	
Course	**Credit**	**Course**	**Credit**
Calculus (IC)	2	Complex Variables and Vector Calculus (IC)	2
Linear Algebra (IC)	2	Applied Electronics (IC)	3
Graphics for Design (IC)	4	Applied Electronics Lab (IC)	2
Computing and Data Science (IC)	4	Data Science II (IC)	4
IC-I Basket (Chemistry Compulsion)	3	IC-II Basket (Physics Compulsion)	3
		Foundations of Design Practicum (IC)	4
HSS Course (Basket)	3	Physics Practicum (IC)	2
IKShma (IKS)	3		
	21		**20**

2nd-Year

Semester-III		Semester-IV	
Course	**Credit**	**Course**	**Credit**
Data Science III (IC)	3	ODE & Integral Transforms (IC)	2
Design Practicum (IC)	3	Basic Quantum and Spectroscopy (CY)	3
Principles of Physical Chemistry (CY)	3	Analytical Chemistry (CY)	3
Principles of Organic Chemistry (CY)	3	Organic Chemistry Lab (CY)	2
Principles of Inorganic Chemistry (CY)	3	Inorganic Chemistry Lab (CY)	2
Physical Chemistry Lab (CY)	2	Discipline Elective-I (CY, E)	3
HSS Course (Basket)	3	HSS Course (Basket)	3
		Free Elective-I	3
	20		**21**

3rd-Year

Semester-V		Semester-VI	
Course	**Credit**	**Course**	**Credit**
Organic Reactions & Mechanisms	3	Photochemistry & Pericyclic Reactions	3
Chemistry of Main Group Elements	3	Chemistry of Transition Elements	3
Advanced Quantum Chemistry	3	Symmetry and Group Theory	3
Discipline Elective-II (E)	3	Stereochemistry & Asymmetric Synthesis	3
Physical Chemistry Laboratory	3	Discipline Elective-III (E)	3
Inorganic Chemistry Laboratory	3	Organic Chemistry Laboratory	3
Research Literature Presentation-I	P/F(1)	Research Literature Presentation-II	P/F(1)
	19		**19**

4th-Year

Semester-VII		Semester-VIII	
Course	**Credit**	**Course**	**Credit**
Discipline Elective-IV (E)	3	Reaction Dynamics, Kinetics & Catalysis	3
Chemical & Statistical Thermodynamics	3	Heterocyclic Chemistry	2
Introduction Organometallic Chemistry	3	Discipline Elective-V	3
Free Elective-II (Spl. or Minor)	3	Free Elective-IV (Spl. or Minor)	3
Free Elective-III (Spl. or Minor)	3	Free Elective-V (Spl. or Minor)	3
Research Lab I (aligned with Minor/Spl)*	6	Research Lab II (aligned with Minor/Spl)*	6
	21		**20**

*Research Lab I and II in the 7th and 8th semesters is optional, students can opt for free electives in place of the research lab if they wish to.

5th-Year

Semester-IX		Semester-X	
Course	**Credit**	**Course**	**Credit**
Discipline Elective-VI (E)*	3	Discipline Elective-VII (E)*	3
Postgraduate Project - I	16	Postgraduate Project - II	16
	19		**19**

*The two discipline elective courses at the MS level 9th and 10th semesters (6 credits) can be completed before without violating the maximum allowed credit in a semester to have more time for MS projects in the 5th year.

**Specific course names, content, and credit structure (L-T-P-C) for the 1st and 2nd year CY courses are being worked out.

3.3. Required courses for chemistry specializations

For specialization in a specific chemistry branch, students need to complete at least *12 credits* from discipline electives with the following mandatory courses (to be updated) specific to a branch.

Organic	Organic Spectroscopy Natural Product Synthesis Asymmetric Organic Synthesis Reagents in Organic Synthesis
Inorganic	Advanced Inorganic Spectroscopy Bioinorganic Chemistry - -
Physical	Computational Chemistry Basic and Applied Electrochemistry Numerical Methods, Computer Programming, Data Analysis -

Material	Science and Technology of Nanomaterials Introduction to Polymer Science & Technology Hydrogen Generation and Storage Applied Polymer and Material Chemistry

3.4. Suggested courses for minors

As per the institute's B.Tech. curriculum requirements. Students can select the free electives as per the minor requirements to obtain minor in a specific branch.

Proposal for B. Tech. in

Mathematics and Computing

School of Mathematical and Statistical Sciences (SMSS)

Indian Institute of Technology Mandi

Programme Proposal Form

Name of the New Proposed Program: B.Tech. in Mathematics and Computing
(Four Years Undergraduate Program)

I. General Information:

Name (s) of prosper school: School of Mathematical and Statistical Sciences (SMSS)

II. Program Description:

A. Provide a justification/rationale for the program. How does the program relate to the mission of the IIT Mandi?

The Bachelor of Technology (B.Tech.) program in Mathematics and Computing is a comprehensive course that integrates the principles of mathematics and computing. This program is designed to equip students with a strong foundation in mathematics, computing, and computational thinking, enabling them to develop and apply analytical and problem-solving skills in a variety of fields in science and engineering. The aim of this program is two-fold, one to provide strong mathematical background for strong logical thinking, and other to prepare students for strong computing skills. The mathematics part will also give them strong foundation which enable them to be leader in the field. The program is design in such way that after important foundational courses, students can choose courses as per their interest in a particular domain.

The program aims to produce graduates who are well-versed in a broad range of mathematical and computational concepts, techniques, and tools. With the help of these skills, students can handle complex real-world problems. It will also enhance the ability of the students looking for solving new challenges in the society. With a focus on both theoretical and practical aspects of mathematics and computing, this program prepares students for a wide range of careers in industries, academia and research & development.

B. SWOT analysis of the program

The purpose of SWOT analysis is to see how B.Tech. in Mathematics and Computing can be implemented in the IIT Mandi's education system.

ADVANTAGES (Strengths-Opportunities)	DISADVANTAGES (Weakness – Threats)
This program is designed to equip students with a strong foundation in mathematics, computing, and computational thinking, enabling them to develop and apply analytical and problem-solving skills in a variety of fields in science and engineering.	Needs to recruit more faculty members in the core areas of Computational Mathematics and Scientific Computing.
The program aims to produce graduates who are well-versed in a broad range of mathematical and computational concepts, techniques, and tools, through which they can handle complex real-world problems. So, the program is design in such way that after	Dedicated teaching labs for providing hands on training to UG students in computational aspects of different engineering branches.

important foundational courses, students can choose courses as per their interest in a particular domain.	
With a focus on both theoretical and practical aspects of mathematics and computing, this program prepares students for a wide range of careers in industries, academia and research & development.	
Very good job market in the core areas of Scientific Computing and Numerical Computing and soft computing.	

C. Justification with respect to New National Education Policy (NEP) mandates

One of the major key points of the new national education policy (NEP) is transformational reforms in school and higher education systems in the country and also to foster interdisciplinary education, and learning by doing. In the proposed B.Tech. program, greater emphasis is given to connection between the fundamentals and analytical abilities, critical thinking, and real-life problem solving. The program is designed in such a way that students should get a strong foundation in mathematics, scientific computing, and computational thinking, which will enable them to develop and apply analytical and problem-solving skills in a variety of fields in science and engineering.

The proposed program aims to produce graduates who are well-versed in a broad range of mathematical and computational concepts, techniques, and tools. With the help of these skills, students can handle complex real-world problems. It will also enhance the ability of the students looking for solving new challenges in the society. With a focus on both theoretical and practical aspects of mathematics and computing, this program prepares students for a wide range of careers in industries, academia and research & development.

D. Provide a mission statement for the program. Include educational and learning objectives

The Bachelor of Technology in Mathematics and Computing program's mission is to prepare graduates who are well-versed in a broad range of mathematical and computational concepts, techniques, and tools, which can enable the students to solve complex real-world problems. With a focus on both theoretical and practical aspects of mathematics and computing, this program will prepare students for a wide range of careers in industries, academia and research & development.

The educational and learning objectives of the B.Tech. in Mathematics and Computing program are:

- Our graduates will be equipped with a strong foundation in mathematics, computing, and computational thinking, which will enable them to develop and apply analytical and problem-solving skills in a variety of fields in science and engineering.
- Our graduates will be trained to become world leaders in the field of scientific computing with strong fundamentals and analytical abilities, and critical thinking.
- With a focus on both theoretical and practical aspects of mathematics and computing, this program will prepare graduates for a wide range of careers in industries, academia and research & development.

E. Credit Structure of the programme.
The typical credit structure of the institute will be followed as shown below.

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)	49
	Discipline Electives (DE)	19
Electives	Free Electives (FE)	21
	Major Technical Project (MTP)	08
	Interactive Socio Technical Practicum (ISTP)	03
	TOTAL	**160**

The credit structure will be followed as per the existing norms of the institute. Out of 160 credits, 49 credits will be dedicated to discipline courses. Total of 19 credits will be assigned for discipline electives. Total of 68 credits will be maintained for DC (49 credits) and DE (19 credits) courses while the rest of the credits will be kept for IC and other institute level courses (92 credits).

B.Tech. (Mathematics and Computing) –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)	3	0	0	3
7	YYXXX	Ikshma Course	3	0	0	3

Total Credits: 21

B.Tech. (Mathematics and Computing) –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. (Mathematics and Computing) –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	MAXXX	Real Analysis	3	1	0	4
4	CS208	Mathematical Foundation of Computer Sciences	3	1	0	4
5	MAXXX	Discipline Elective				3
6	FE	Free Elective				3

Total Credits: 20

B.Tech. (Mathematics and Computing) – 4th Semester						
S.No	Code	Course Name	Lecture	Tutorial	Practical	Credit
1	MA522	Partial Differential Equation	3	1	0	4
2	CS201	Computer Organization	3	0	0	3
3	CS201P	Computer Organization Laboratory	0	0	2	1
4	MA523	Numerical Analysis	3	1	0	4
5	MA515	Applied Mathematics Programming	3	1	0	4
6	HSXXX	HSS Course				3
7	FE-1	Free Elective				3

Total Credits: 22

B.Tech. (Mathematics and Computing) – 5th Semester						
S.No	Code	Course Name	Lecture	Tutorial	Practical	Credit
1	MAXXX	Graph Theory	3	1	0	4
2	MA609	Numerics of PDEs	3	0	0	3
3	CSXXX	Design of Algorithms	3	0	2	4
4	MAXXX	Discipline elective				3
5	FE	Free Elective				3
6	HSSXXX	HSS or Management course				3

Total Credits: 20

B.Tech. (Mathematics and Computing) – 6th Semester						
S.No	Code	Course Name	Lecture	Tutorial	Practical	Credit
1	CS302	Paradigms of Programming	3	0	2	4
2	MAXXX	Functional Analysis	3	0	0	3
3	EEXXX	Computer Organization & Processor Architecture Design	3	0	2	4
5	DE	Discipline elective	3	0	0	3
6	HSSXX	HSS or Management course				3
7	ISTP					4

Total Credits: 21

B.Tech. (Mathematics and Computing) – 7th Semester						
S.No	Code	Course Name	Lecture	Tutorial	Practical	Credit
1	MAXXX	Matrix Computation with Lab	2	0	2	3
2	DE	Discipline elective				3
3	FE	Free Elective				3
4	FE	Free Elective				3
5	MTP-1	MTP-1 (project)				4
6	IC 010	Internship				2

Total Credits: 18

B.Tech. (Mathematics and Computing) –8th Semester						
S.No	Code	Course Name	Lecture	Tutorial	Practical	Credit
1	DE	Discipline Elective				3
2	DE	Discipline Elective				3
3	FE	Free Elective				3
4	FE	Free Elective				3
5	MTP-2	MTP-2 (project)				4

Total Credits: 16

Grand Total: 160 credits for B.Tech. in Mathematics and Computing

Annexure E

Master of Science
in
Applied Mathematics

Programme Level	Post Graduate
Year of Commencement	2016
Minimum Duration	2 Years (4 Semesters)
Maximum Duration	3 Years (6 Semesters)
Senate Meeting Reference	9.3/18.5/20.4

Preamble : M.Sc. in Applied Mathematics program at IIT Mandi has many distinctive features that set it apart from the conventional master's in mathematics programs in the country. It is intended to give the students an in-depth exposure of the essential areas of Mathematical sciences while expanding their knowledge in the allied areas through elective courses. The unique curriculum of the program is designed in such a way that students are not only skilled to take up research career in academia but are also well equipped to take up R&D jobs in industry after the completion of the program.

The hallmark of the program is its broad based curriculum with interdisciplinary approach that provides a good balance among theory, application, and research components. In the first year of the program the students make a strong foundation through carefully designed core courses. In the second year, the option to choose courses from a large pool of electives offered within and outside the school enables the students to build a strong foundation in the area of their interest and empower them to work on challenging application problems in various fields.

The final year project is one of the most important component of the program that gives an all-round learning experience to the students with an early career training to start working on challenging research problems. While working on the project, students not only enhance the understanding of the concepts learned in the courses but also get an exposure to *learning by doing*, an important aspect that give them confidence and ability to independently carry the research work.

- Unique broad based curriculum with a strong focus on essential fundamental concepts.
- Option for choosing courses from a pool of discipline and free electives for in-depth exposure to individuals area of interests.
- Interdisciplinary approach wherein students blend the mathematical concepts and their application to different domains.
- Learning of advanced mathematical and computational tools to solve engineering and real-life problems.
- Emphasis on project based learning for exposure to different aspects of solving research problems.
- Courses and project together put strong emphasis on problem solving skills that gives an advantage while targeting for jobs in industry.

Semester-wise credit distribution :

Semester-I		**Semester-II**	
Real Analysis(MA-511)	4 Credit	Functional Analysis(MA-521)	4 Credit
Linear Algebra(MA-512)	4 Credit	Partial Differential Equation(MA-522)	4 Credit
Ordinary Differential Equation(MA-513)	4 Credit	Numerical Analysis(MA-523)	4 Credit
Computer Programming(MA-514)	3 Credit	Probability and Statistics(MA-524)	4 Credit
Computer Programming Lab(MA-514P)	2 Credit	Discipline Elective- I	4 Credit
Applied Mathematical Programming(MA-515)	4 Credit	Technical Communication(HS-541)	1 Credit
Total	21 Credit	**Total**	21 Credit

Semester-III		**Semester-IV**	
Discipline Elective - II	3 Credit	Discipline Elective - VII	3 Credit
Discipline Elective - III	3 Credit	Elective - VIII	3 Credit
Elective - IV	3 Credit	Elective - IX	3 Credit
Elective - V	3 Credit	Project (Part-2)	8 Credit
Elective - VI	3 Credit		
Project (Part-I)	6 Credit		
Total	21 Credit	**Total**	17 Credit

- **Credit Structure:** A student, to be awarded M.Sc. degree, must need to earn 80 credits.
- **Open Electives:** Open electives from outside the discipline of program should be at least of 6 credits.
- **Discipline Electives:** Discipline electives will be provided according to the requirement of the students and the availability of the faculties. The list of discipline electives are attached herewith.
- **Discipline Elective Courses:** The following existing senate approved courses can be offered as discipline electives. More elective courses will be added time to time as required.

List of Discipline Elective Courses*

Course Numbers	Course Titles	Credits
MA-549(4)	Abstract Algebra	4
MA-552(3)	Number Theory	3
MA-780 (3)	Topics in Semigroup Theory	3
MA-550(3)	Statistical Data Analysis	3
MA-553(3)	Mathematical Foundations of Financial Engineering	3
MA-565(3)	Numerical Methods in Quantitative Finance	3
MA-608(3)	Computational Fluid Dynamics	3
MA-609(3)	Numerics of Partial Differential Equation	3
MA-651(3)	Optimization Techniques	3
MA-652(3)	Stability Theory of Differential Equations	3
MA-653(3)	Computational Financial Modelling	3
MA-653P(1)	Computational Financial Modelling Lab	1
MA-654(3)	Financial Engineering	3
MA-656(3)	Stochastic Calculus for Financial Engineering	3
MA-704(3)	Dynamical System	3
MA-705(3)	Modeling Population Dynamics	3
MA-709(3)	Numerical Linear Algebra	3
MA-765(4)	Fractional Differential Equations	4
MA-516(4)	Topology	4
MA-611(4)	Statistical tools and Computing	4
MA-527(4)	Field and Galois Theory	4
MA-528(4)	Graph Theory	4
MA-5XX(4)	Measure Theory and Integration	4
MA-525(3)	Heuristic Optimization	3
MA-560(3)	Nonlinear Dynamics and Chaos	3
MA-605(3)	Statistical Data Analysis	3
MA-510(3)	Climate Change Analysis	3
MA-611(3)	Statistical tool and computing	3

* This is a dynamic list of elective courses that may be updated based on the requirements.

Project: The project focuses on an interdisciplinary approach wherein students learn theory and its applications, those are required for research in Mathematics and industry jobs. Students need to complete 14 credit project in the third and fourth semester. We offer the research projects on the following topics:

1. Differential Equations
2. Mathematical Control Problems
3. Optimization,
4. Soft Computing
5. Machine Learning
6. Financial Mathematics
7. Dynamical Systems
8. Nonlinear Dynamics
9. Harmonic Analysis
10. Wavelet Analysis
11. Computational Fluid Dynamics
12. Numerical Methods for PDEs
13. Topology and Combinatorics
14. Algebraic Topology
15. Classical K-theory, Commutative Algebra
16. Statistical Time Series Analysis
17. Climate Modelling
18. Ecological Modelling
19. Deep Learning
20. Any Interdisciplinary Topics with applications in Mathematics

In project, students are expected to read research papers, advance mathematical courses and to do literary survey about research problems and their application to the real life problems. Also, some motivated students works on new research topic suggested by their project mentor.

Project Evaluation: A continuous evaluation process will be followed to evaluate the project/thesis work progress to award letter grades for the credits assigned to project/thesis component, as mentioned in the institute's Ordinance for M.Sc. programme.