Maulana Abul Kalam Azad University of Technology, West Bengal
(Formerly West Bengal University of Technology)

BACHELOR OF SCIENCE IN MATERIALS SCIENCE
Curriculum Structure

BACHELOR OF SCIENCE

IN

MATERIALS SCIENCE

(Applicable from the academic session 2019-2020)

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Haringhata-741249, Nadia, West Bengal, INDIA

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Preamble:

Department of Materials Science and Technology under School of Natural and Applied Sciences of Maulana Abul Kalam Azad University of Technology West Bengal is introducing a three years Bachelors Course in Materials Science (BSc- Materials Science), with an emphasize on computational techniques associated with Materials Science and Technology. The under graduate syllabus has been designed following the recommendations and guidelines of University Grants Commission (UGC) prescribed for the according to the Semester Wise Choice Based Credit System (CBCS) scheme. The contents, structure and date of effect of the proposed syllabus will be decided by the board of studies (B.O.S) of the department following its acceptance and approval.

The B.Sc. Course is systematically designed where students shall be trained on the fundamentals of Physics, Chemistry Mathematics, and Computational Techniques required for understanding materials and develop different advanced materials. During framing of this syllabus for B.Sc. (Honours) in Materials Science, substantial weightage has been given in both the core subjects as well as skill and ability enhancement of the students. The ultimate goal of the syllabus is to enable the students to have an in-depth knowledge of the subject/s and enhance their scope of employment in the industry. The programme shall enable students to develop a deeper understanding of various aspects of computational materials science.

First year of under-graduate study (Semester I &II): During the first two semesters students shall be exposed with six core courses, giving emphasis on basic sciences and mathematics that teaches them materials behaviour: atomic bonding, thermodynamics, mechanics, and crystal defects. Along with these core courses, special emphasise shall be given to make students digitally equipped. They will learn to handle different computational software and tools like MATLAB along with computer language C++.

Second year of under-graduate study (Semester III &IV): The scientific foundation shall be further strengthened by a strong curriculum content consisting of courses in**:** Kinetics of Materials and Transport Phenomena, Materials Behaviour: Mechanical, Electrical & Magnetic, Structure of Materials and processing of materials. A vibrant set of skill enhancement elective (Basics of Artificial Intelligence; Basics of Block Chain Technology, Basics of IOT, Basics of AR/VR) and generic elective (Thinking and Acting like an Entrepreneur; Disciplined approach to Social Entrepreneurship) courses shall give the students flexibility and exposure to some other discipline/subject/domain which would nurture the candidate's proficiency/skill. Tutorials and laboratories will complement traditional lectures.

Third year of under-graduate study (Semester V &VI): The core course is specially designed giving adequate emphasis on the new and emerging techniques and understanding of the materials science under the changing regime and global context. The summers are about giving an exposure to practice: materials research through mini-projects, as well as industrial visits.

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Special care shall be taken for developing entrepreneurship capacity building and excellent opportunity shall be provided to improve extra-curricular and leadership skills.

The final year project is a key part of the curriculum, this can be chosen from a variety of topics given to the students or even students may implement their ideas into practice. Students will get to work on exciting research ideas ranging from fundamentals of materials to applications of materials emphasizing on upcoming computational techniques. The summers are about giving an exposure to practice materials research through mini-projects, as well as industrial visits.

During the design of the syllabus, we refer the syllabus of few National and International Universities, the names of the institutes are placed hereunder:

National Universities

1. IISC Bangalore- B.Sc (Research) in Materials (Consulted for the course pattern and subjects of Materials Science)

2. Calcutta University, West Bengal (Consulted for CBCS structure of B.Sc (H) course and for the subject for basic Physical Science)

3. Delhi University, Delhi (Consulted for CBCS structure of B.Sc (H) course and for the subject for basic Physical Science)

International Universities/Institutes

1. University Manchester-UK (Consulted for the subjects of Materials Science))

2. MIT-USA (Consulted for the subjects of Materials Science)

3. Illinois Institute of Technology, USA (Consulted for the course pattern and subjects of Materials Science)

4. Wright State University, USA (Consulted for the course pattern and subjects of Materials Science)

As per the rules of MAKAUT WB, a total of 120 credit points has to be earned by the student to obtain the degree of B.Sc (General) in Materials Science while further 16/20 credit has to be earned from online MOOCs (Massive Open Online Courses) offered by Coursera, edX, nptel, nanoHub to get the degree of B.Sc (Honours) in Materials Science.

Hope the proposed curriculum will make it more contextual, viable and suitable to cater the needs of students of Materials Science.

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OUTLINE OF CHOICE BASED CREDIT SYSTEM

1. Core Course: A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

2. Elective Course: Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

2.1 Discipline Specific Elective (DSE) Course: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

2.2 Dissertation/Project: An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.

2.3 Generic Elective (GE) Course: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.

3. Ability Enhancement Courses (AEC): The Ability Enhancement (AE) Courses may be of two kinds: **Ability Enhancement Compulsory Courses (AECC)** and **Skill Enhancement Courses (SEC).** "**AECC**" courses are the courses based upon the content that leads to Knowledge enhancement; **i. Environmental Science** and **ii. English/MIL Communication**. These are mandatory for all disciplines. **SEC** courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.

3.1 Ability Enhancement Compulsory Courses (AECC): Environmental Science, English Communication/MIL Communication.

3.2 Skill Enhancement Courses (SEC): These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based knowledge.

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- Introducing Research Component in Under-Graduate Courses

Project work/Dissertation is considered as a special course involving application of knowledge in solving / analysing /exploring a real life situation / difficult problem. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.

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PROPOSED SCHEME FOR CHOICE BASED CREDIT SYSTEM of B.Sc in MATERIALS SCIENCE

For B.Sc (Hons.) Course. As per CBCS, student needs to earn 140 credits For B.Sc (General) Course. As per CBCS, student needs to earn 120 credits								
SEMESTER	**Core Course (CC) (14 courses)** **Total Credit:** $4_{\text{theo credits}} + 2_{\text{pract credits}}) * 14$ courses $[56_{\text{theo credits}} + 28$ pract credits$]$ **= 84 credit courses** $5_{\text{theo credits}} + 1_{\text{pract credits}}) * 14$ courses $[70_{\text{theo credits}} + 14$ pract credits$]$ **= 84 credit courses**	**Ability Enhancement Compulsory Course (AECC) (2 Courses)** **Total credit:** $2_{\text{theo credits}} * 2$ courses **= 4 credit courses**	**Skill Enhancement Course (SEC) (2 Courses)** **Total Credit:** $2_{\text{theo credits}} * 2$ courses **= 4 credit courses**	**Elective: Discipline Specific (DSE) (4 Courses)** **Total Credit:** $4_{\text{theo credits}} + 2_{\text{pract credits}}) * 4$ courses $[16_{\text{theo credits}} + 8_{\text{pract credits}}]$ **= 24 credit courses** $5_{\text{theo credits}} + 1_{\text{pract credits}}) * 4$ courses $[20_{\text{theo credits}} + 4$ pract credits$]$ **= 24 credit courses**	**Elective: Generic (GE) (4 Courses)** **Total Credit:** $4_{\text{theo credits}} + 2_{\text{pract credits}}) * 4$ courses = $[16_{\text{theo credits}} + 8_{\text{pract credits}}]$ **= 24 credit courses** $5_{\text{theo credits}} + 1_{\text{pract credits}}) * 4$ courses $[20_{\text{theo credits}} + 4$ pract credits$]$ **= 24 credit courses**	**Lecture hour**	**Marks (100)**	
							Theory 75	**Practical 25**
I	**CCI (BMS 101):** **4Credits** Fundamentals of Materials						**120**	**75**	
	Lab I (BMS 191): **2credits** Macroscopic and Microscopic Lab Examination of						**60**		**25**

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	Materials							
	CC II (BMS 102): 4$_{Credits}$ Mathematics I: Vector & Calculus					**120**	**75**	
	Lab II (BMS 192): 2$_{credits}$ Introduction to Programming using C and MATLAB					**60**		**25**
	CCIII (BMS 103): 4$_{Credits}$ Classical Physics for Materials Science					**120**	**75**	
					GE I (BMS104): 4$_{credits}$ Statistical Methods for Materials Science – I	**120**	**75**	
					Lab III (BMS 193): 2$_{credits}$ Statistical Analysis Lab through Software	**60**		**25**
		AECC101: 2$_{credits}$ Communicative English				**60**	**50**	

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Total credit earned after SEM-I = 24	**16**	**2**			**6**	**720-hour lectures**	**350**	**75**
II	**CC IV (BMS 201): $4_{Credits}$** Quantum Physics for Materials Science					**120**	**75**	
	CC V (BMS 202): $4_{Credits}$ Materials Chemistry					**120**	**75**	
	Lab I (BMS 291): $2_{credits}$ Materials Synthesis Lab					**60**		**25**
	CC VI (BMS 203): $4_{Credits}$ Mathematics II: Linear Algebra					**120**	**75**	
					GE II (BMS204): $4_{credits}$ Statistical Methods for Materials Science – II	**120**	**75**	
					Lab II (BMS 292): $2_{credits}$ Data Analysis, Visualization and	**60**		**25**

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					Interpretation using MATLAB			
		AECC201: **2**$_{\text{credits}}$ Environment & Sustainability				**60**	**50**	
Total credit earned after SEM-II = 22	**14**	**2**			**6**	**660-hour lectures**	**350**	**50**
III	**CC VII (BMS 301):** **4**$_{\text{Credits}}$ Thermodynamics of Materials					**120**	75	
	CC VIII (BMS 302): **4**$_{\text{Credits}}$ Kinetics of Materials and Transport Phenomena					**120**	**75**	
	CC IX (BMS 303): **4**$_{\text{Credits}}$ Structure of Materials					**120**	**75**	
	Lab I (BMS 391): **2**$_{\text{credits}}$ Introduction to Programming using Python					**60**		**25**
	Lab II (BMS 392): **2**$_{\text{credits}}$					**60**		**25**

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	Introduction to Finite Element Analysis							
			SEC 301 (A/B/C/D): 2$_{credits}$ Basics of AI; Basics of Block Chain Technology, Basics of IOT, Basics of AR/VR			**60**	**50**	
					GE II (BMS304): 6$_{credits}$ (Theo. + Tutorial) Thinking and Acting like an Entrepreneur	**180**	**100**	
Total credit earned after SEM-III = 24	**16**		2		**6**	**720-hour lectures**	**375**	**50**
IV	**CC X (BMS 401): 4$_{Credits}$** Phase Equilibria and Phase Transformation					120	75	
	CC XI (BMS 402): 4$_{Credits}$					**120**	**75**	

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	Materials Behavior: Mechanical, Electrical & Magnetic							
	CC XII (BMS 403): $4_{Credits}$ Processing of Bulk Materials					**120**	**75**	
	Lab I (BMS 491): $2_{credits}$ Intermediate Programming with Python					**60**		**25**
	Lab II (BMS 491): $2_{credits}$ Materials Behaviour Lab					**60**		**25**
					GE IV (BMS304): $6_{credits}$ (Theo. + Tutorial) Disciplined approach to Social Entrepreneurship	**180**	**100**	
			SEC 401 (A/B/C/D): $2_{credits}$ Basics of AI; Basics of Block Chain			**60**	**50**	

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			Technology, Basics of IOT, Basics of AR/VR					
Total credit earned after SEM-IV = 24	**16**		2		**6**	**660-hour lectures**	**375**	**50**
V	**CC XIII (BMS 501): $4_{Credits}$** Thin films and Nano Materials					**120**	**75**	
	CC XIV (BMS 502): $4_{Credits}$ Materials Behavior: Electronic and Optical					**120**	**75**	
	Lab I (BMS 591): $2_{credits}$ Nano-Materials Lab					**60**		**25**
				DSE I (BMS503): $6_{credits}$ Metallic Materials, Polymeric Materials, Ceramic Materials, Composites		**180**	**100**	
				DSE II (BMS504): $4_{credits}$ Data Science and		**120**	**75**	

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				Informatics for Materials, Computational Materials Science, Atomistic Simulation and Predictive Theory				
				Lab III (BMS 593): 2credits Computational Materials Design Lab		**60**		**25**
Total credit earned after SEM V = 24	**10**			12		**660-hour lectures**	**325**	**50**
VI	**CC XV (BMS 601): 4$_{Credits}$** Materials Characterization					**120**	**75**	
	Lab I (BMS 691): 2$_{credits}$ Materials Characterization Lab					**60**		**25**
	CC XVI (BMS 602): 6$_{Credits}$ (Theo. + Tutorial) Design and Selection of Materials					**180**	**100**	

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				DSE I (BMS503): $6_{credits}$ **This may be replaced by Project of 6 credits**		**180**	**100**	
				DSE II (BMS604): $4_{credits}$ Data Science and Informatics for Materials, Computational Materials Science, Atomistic Simulation and Predictive Theory		**120**	**75**	
				Lab III (BMS 693): 2credits Computational Materials Design Lab		**60**		**25**
Total credit earned after SEM-VI = 24	**12**			**12**		**720-hour lectures**	**325**	**75**
	84 credits	**4 credits**	**4 credits**	**24 credits**	**24 credits**	**4140 hrs**	**2100**	**350**

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In CBCS, all courses have credits assigned to them.

For any course, one of the following three modes teaching will be used:

1. Theory + Practical
2. Theory + Tutorial
3. Theory only

N.B:

1 Credit = 30 contact hours

For Honours degree student earn minimum of 140 credits in 3 years *[out of which up to maximum 20 credits may be earned from the MOOCs basket]*

Core Course =		84 Credits
Discipline Specific Elective =		24 Credits
Generic Elective	=	24 Credits
Ability Enhancement Course =		4 Credit
Skill Enhancement Course =		4 Credits
Total Credit	**=**	**140 Credits**

For General degree student earn minimum 120 credits in 3 years

Core Course =		72 Credits
Discipline Specific Elective =		36 Credits
Ability Enhancement Course =		4 Credit
Skill Enhancement Course =		8 Credits
Total Credit	=	120 Credits

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As per CBCS UGC norms up to maximum 25% of credit may be accumulated from the MOOCs (under open elective courses, i.e. DSE & GE)

Special Note:

Across all courses (for both, Honours and General) 10 marks will be reserved for Internal Assessment and 10 marks will be reserved for Attendance.

MOOCs Basket

Sl. No.	Course Name	Course Provider	Course Duration	Credits	Name of University/Institute
1	Data Science and Informatics for Materials	Coursera	4 weeks	2	Georgia Institute of Technology
2	Computational Materials Science	nanoHUB	6 weeks	2	University of Illinois
3	Atomistic Simulation and Predictive Theory	nanoHUB	5 weeks	2	Purdue University
4	Understanding Nuclear Energy	edX	6 weeks	2	Delft University of Technology
5	Waste to Energy Conversion	NPTEL	8 weeks	3	IIT Roorkee
6	Introduction to High Throughput Materials	Coursera	4 weeks	2	Georgia Institute of Technology
7	Fundamental concepts of semiconductors	NPTEL	6 weeks	2	IIT Delhi
8	Electromagnetic Theory	NPTEL	4 weeks	2	IIT Bombay
9	Materials in Oral Health	Coursera	4 weeks	2	University of Hong Kong

10	Climate Change Education	edX	4 weeks	2	IDBx
11	Computational Approach to Materials Science and Engineering	NPTEL	6 weeks	2	IIT Bombay
12	Physics of Materials	NPTEL	8 weeks	3	IIT Madras
13	Optoelectronics Materials and Devices	NPTEL	8 weeks	3	IIT Kanpur
14	Diffusion in Solids	NPTEL	8 weeks	3	IISc Bangalore
15	Introduction to Chemistry: Reactions and Ratios	Coursera	8 weeks	3	Duke University
16	Introduction to Physical Chemistry	Coursera	10 weeks	3	The University of Manchester
17	Cement Chemistry and Sustainable Cementitious Materials	edX	6 weeks	2	Swiss Federal Institute of Technology in Lausanne (EPFL)
18	Introduction to Artificial Intelligence (AI)	edX	4 weeks	2	Microsoft