GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Metallurgy
Subject Code : BE05021061
Subject Name: Advanced Materials & Seminar

w. e. f. Academic Year:	2024-25
Semester:	5
Category of the Course:	Professional Elective Course - 1

Prerequisite:	**Nil**
Rationale:	Materials have an important role in every field of engineering. The materials we use and how we make them can determine the function, feasibility, cost, environmental impact and many other aspects of things we create. Advanced Materials are the materials used in "High-Tec" applications, usually designed for maximum performance. Examples are titanium alloys for supersonic airplanes, magnetic alloys for computer disks, special ceramics for the heat shield of the space shuttle, etc. Metallurgy engineers design new materials, select the best material for a particular job, monitor its performance and figure out why a material failed and bring expertise on the properties of materials. This course is to prepare students for careers where knowledge of properties and applications of different advanced materials can be applied for the selection of candidate material for a given task. This course will enable students to solve metallurgical problems upon graduation while at the same time, provide a firm foundation for the pursuit of graduate studies in metallurgy engineering.

Course Outcome:

After Completion of the Course, Student should be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the composition, properties, and applications of special steels, alloy cast irons, light metal alloys and superalloys.	45
CO-2	Explain the properties, and applications of biomaterials, nano-materials, smart materials, miscellaneous advanced materials, etc.	45
CO-3	Identify and select advanced materials for suitable engineering applications.	10

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/ CA (I)	PBL* (I)	ESE (V)	
45	0	30	15	90	03	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End Semester Examination, PA = Progressive Assessment
*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1	**Special steels** Composition, Properties and applications of: Different Stainless steels, Dual phase steels, TRIP steels, Maraging steels, High speed steels, Hadfield steels, Free cutting steels, Ausformed steels, Tool Steels, Bearing steels, spring steels, HSLA steels etc..	12	26
2	**Alloy cast iron** Need of alloying. Silal, Nicrosilal, High silicon cast iron, Ni-hard, Heat resistant cast iron: Composition, effect of alloying elements, properties and applications.	03	7
3	**Light metals and their alloys** Aluminium, magnesium and titanium alloys: Metallurgical aspects, properties and applications.	03	7
4	**Super alloys** Iron base, nickel base and cobalt base super alloys: Strengthening mechanism, composition, properties and applications.	04	9
5	**Biomaterials** Property requirement, biocompatibility, bio functionality, important bio metallic alloys like: Ni-Ti alloy and Co-Cr-Mo alloys, applications.	04	9
6	**Nano materials** Definition, Types, Properties and applications, Carbon nano tubes, Methods of production.	05	11
7	**Smart materials** Shape memory alloys, Piezoelectric materials, Electro-rheological fluid, Magneto- rheological fluids.	05	11
8	**Miscellaneous Advanced Materials** Ceramics, Composites, Surface composites, Metallic glasses, Aerospace materials, Cryogenic materials, Semi conducting and Superconducting materials.	09	20
	Total	45	100

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	**30**	**40**	**10**	**0**	**0**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

The syllabus of Advanced Materials & Seminar directly contributes to:

SDG 4	Quality Education
SDG 9	Industry, Innovation and Infrastructure
SDG 12	Responsible Consumption and Production

Reference Books:

1. The Science and Engineering of Materials by D. R. Askeland and P. P. Phule, Thomson Publication
2. Advances in Material Science by R. K. Dogra and A. K. Sharma
3. Material science by Van Black.
4. Engineering Materials and Applications by R. A. Flinn and P. K. Trojan
5. Materials, their Nature, Properties and Fabrication by R. A. Lindberg and S. D. Sehgal, S Chand & Co.
6. Light Alloys: Metallurgy of Light Metals by I. J. Polmear
7. Engineering Materials: Properties and applications of Metals and alloys by CP Sharma, PHI
8. Engineering Materials: Polymers, ceramics and composites by AK Bhargava, PHI
9. Nano Technology by AK Bandyopadhyay, New age international publishers

Laboratory sessions:

Laboratory sessions in the Advanced Materials & Seminar course will consist of a mini project that includes study (market, literature, etc.), review, group discussion and presentation of selected topics related to the subject content in general. Each group of students will be assigned a topic related to recent advancements in the area of advanced materials and metallurgy engineering by the concerned faculty. Students will do a literature survey; study and practice the minimum 03 presentation of his/her work in the batch during the semester. Students will write a report and present the same at the time of the final presentation in the group.

The exercises should be properly designed and implemented with an attempt to develop different types of cognitive and practical skills (Outcomes in cognitive, psychomotor and affective domain) so that students are able to acquire the competencies. However, if these exercises are completed appropriately,

they would also lead to development of Program Outcomes/Course Outcomes in the effective domain for this program.

List of Open Source Software/learning website:

1. http://nptel.iitm.ac.in/
2. www.ocw.mit.edu

List of suggested activities for Problem-based Learning (PBL):

Sr. No.	PBL Category	Name of the activity	No. of hours	Evaluation Criteria
1	Industry / Research Laboratory Visit	Industry / Research laboratory Visit	Visit = 5hrs, Report preparation = 5hrs Total = 10hrs	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2	Video Based Learning	Technical Video based learning related to the subject (MOOC/ NPTEL Video)	Duration of video = 5hrs Report preparation = 5hrs Total = 10hrs	Report /presentation based on the video learning outcomes.
		Self-learning on-line course	Minimum duration of the course should be 10hrs.	Examination based assessment at the end of course. Based on the certificate produced.
		Annotated Video Explanation of Concept/Problem	10hrs (Preparation + Recording + Submission)	Based on accuracy of explanation, clarity, and presentation style.
3	Assignment/ Technical Writing / Research Writing	Assignment writing. Numerical based assignment is preferable.	5 assignments of 2hrs each. Total = 10hrs	Based on the assignment submitted.
		Blog or Technical Article Writing	10hrs (Research – 6hrs, Writing – 4hrs)	Based on originality, technical content, references cited, and clarity of communication.
4	Complex Problem-Solving targeting relevant SDGs. / Mini Project	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 15 hrs	Based on the depth of the solution submitted.

5	Research Paper Review / Analysis	Discussion on research paper based on relevant subject (Indexed Journal)	5 research paper = 20 hrs	Summarize research paper and evaluate critical parameters
6	Poster/ Chart/ Power point presentation	Poster/chart/power point preparation on technical topics	Duration = 6 hrs	Based on poster/chart preparation and presentation skills
7	Micro Project	Working/non-working model on technical topics	Working = 10 hrs Non-working = 10 hrs	Based on inter department/external evaluation
8	Group Discussion / Quiz / Simulation	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 hrs each	Based on performance in group discussion, technical depth, knowledge etc.
		Online Technical Quizzes/ MCQ test/ Simulations	Multiple quizzes summing up to 10hrs	Based on quiz score and reflection summary.
9	Case Study Analysis / Seminar	Real world case studies-based learning	Duration of data collection/study = 5hrs Report preparation = 5hrs Total = 10hrs	Based on in-depth study, technical depth, data collected, fact finding, etc.
10	Other	Patent Search and Innovation Gap Identification	10hrs (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.

Note:

1. In alignment with Outcome-Based Education (OBE) and NBA accreditation requirements, the subject Advanced Materials & Seminar incorporates;

- Mini Project – 10 Marks
- Micro Project and – 5 Marks
- Seminar activities -– 10 Marks

These activities are incorporated as integral Project-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications of power converter design, simulation, and analysis. The inclusion of PBL ensures that learners develop higher-order cognitive abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice.

2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.

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