GUJARAT TECHNOLOGICAL UNIVERSITY
Program Name: Minor/Hons. Program
Level: UG
Branch: Minor/Hons. 3 D Printing
Subject Code: BE050AN011
Subject Name: Materials for Additive Manufacturing

w. e. f. Academic Year:	2026-27
Semester:	**5**
Category of the Course:	Core Courses

Prerequisite:	None
Rationale:	This course aims to familiarize students with basic fundamentals of Materials to be used for Additive Manufacturing.

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	Understand the essential properties and characteristics of Different 3D Printing Material.	20
CO-2	Select additive manufacturing process for a given material and application.	30
CO-3	Analyse the polymerization processes and the significance for 3DP.	30
CO-4	Differentiate different 3D printing materials for future application	20

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA (I)	PBL (I)	ESE (V)	
45	0	0	45	90	3	70	0	0	30	0	100

**** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.***

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

Content:

Sr. No.	Content	Total Hrs
1	**Plastic 3D Printing Materials and Processes:** Introduction to thermoplastics and thermosetting plastics; types of polymerizations; properties of polymers and degradation mechanisms. Study of chemical, optical, mechanical, and thermal characteristics of plastics. Material requirements based on tensile strength, flexural modulus, elongation, impact strength, heat deflection temperature, hardness (durometer), tear strength, creep, and compression set.	9

2	**Polymers & Its Processing:** Classification of polymers, concept of functionality, polydispersity, and molecular weight (MW). Molecular weight distribution (MWD) and methods of its determination. Overview of spinning techniques for additive manufacturing including wet spinning and dry spinning. Introduction to biopolymers and compatibility issues with conventional polymers.	8
3	**Powder materials:** Introduction and history of Powder Metallurgy (PM), present and future trends, powder production techniques, mechanical and chemical methods, atomization processes, and emerging powder manufacturing techniques. Performance evaluation, design, and selection of processes. Study of microstructure control in powders, powder shaping, ceramic sintering, sintering of single and mixed-phase powders, and liquid phase sintering.	5
4	**FDM 3D Printing Materials:** Properties, structure, and applications of ABS (Acrylonitrile Butadiene Styrene), PLA (Polylactic Acid), PETG (Polyethylene Terephthalate Glycol), Nylon, TPU (Thermoplastic Polyurethane), PVA (Polyvinyl Alcohol), HIPS (High Impact Polystyrene), and composites such as carbon fiber, Kevlar, and fiberglass.	7
5	**SLA 3D Printing Materials:** Resin formulations with a wide range of optical, mechanical, and thermal properties comparable to standard, engineering, and industrial thermoplastics. Types of resins include Standard, Clear, Draft, Tough and Durable, Rigid, High Temperature, Flexible and Elastic, Medical and Dental, Jewelry, and Ceramic resins	6
6	**SLS 3D Printing Materials:** Nylon 12, Nylon 11, TPU, and nylon composites, with emphasis on structure, properties, and applications.	5
7	**Metal 3D Printing Materials:** Structure, properties, and applications of metals such as Titanium, Stainless Steel, Aluminum, Tool Steel, and Nickel Alloys.	5
TOTAL		**45**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
25	25	25	25	--	---

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Reference Books:

1. Dongdong Gu, Laser Additive Manufacturing of High-Performance Materials, Springer, 2015.
2. GOdian Principles of Polymerization, Wiley Inerscience John Wiley and Sons, 4th edition, 2005.
3. Li Yang · Keng Hsu · Brian Baughman Donald Godfrey · Francisco Medina Mamballykalathil Menon. Soeren Wiener, Additive Manufacturing of Metals: The Technology, Materials, Design and Production, Springer, 2017.
4. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", 2nd Edition, Springer, 2015.
5. William D Callister Jr, David G Rethwisch,"Material Science and Engineering: An Intr oduction,
10^{th} Edition

List of Tutorials: nil

List of Open Source Software/learning website:

https://onlinecourses.nptel.ac.in

List of suggested activities for Problem Based Learning:

Sr. No.	Name of the activity	No. of hours	Evaluation Criteria
1	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	Technical Video based learning related to the subject	Duration of video = 5hrs. Report preparation = 5hrs. Total = 10hrs.	Report/presentation based on the video learning outcomes.
3	Problem solving/Coding using C, C++, MATLAB, Python, SCILAB modeling and Analysis software or any other software	5 small coding-based assignment of 2hrs. each. Total = 10hrs.	Based on the coding solution submitted.
4	Self-learning online course	Minimum duration of the course should be 10hrs.	Examination based assessment at the end of course. Based on the certificate produced.
5	Technical paper reading and summarization of research papers	5 research papers = 20 hrs.	Summarize research paper and evaluation critical parameters based on relevant subject.
6	Poster/chart/power point preparation on technical topics	Duration = 6 hrs.	Based on poster/chart preparation and presentation skills.
7	Working/non-working model on technical topics	Working = 12 hrs. Non-working = 8 hrs.	Based on inter department/external evaluation.

8	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/sustainability/any other issue	Duration = 15 hrs. for industrial exposure. Problem identification and tentative solution = 10 hrs. Total = 20 hrs.	Based on evaluation of critical problems and solutions.
9	Group Discussion on emerging/trending technical topics based on subject	Duration = Min. 1 hr per subject. Max. 3 hrs. per subject.	Based on performance in group discussion, technical depth, knowledge etc.
10	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.
11	Application/Software development	Duration = 10 hrs.	Depending on the complexity of the Application/Software.
12	Research paper publication	Duration = 10 hrs.	Based on submission of proof of publication.
13	Upgradation/Reverse engineering studies of existing equipment of the laboratory	Duration 10 hrs.	Based on the performance of the equipment.
14	Expert lecture/session	Duration 3 hrs. For attending the lecture/session - 2 hrs. and for report writing 1 hr.	Based on the proof of attendance and report submitted.
15	Annotated Video Explanation of Concept/Problem	10h (Preparation + Recording + Submission)	Based on accuracy of explanation, clarity, and presentation style.
16	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.

Note:
1. All the suggested activity should be related to the subject.
2. The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
3. Rubrics for the evaluation can be prepared by the faculty.
4. Subject teacher can add the relevant activities other than those listed above, with the consent of head of the department and DQAC.

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