Section 1: Administrative and Core Identity

Project Title

Development of 3D Printed Non-Conventional Implants for Medical Applications and its Feasibility Studies

Student Team

Sl. No.	Student Name	Role in Project
1	Hithali Dinesh	Literature Survey, Research Documentation, Conference Presentation
2	Bhoomika B K	Project Development, 3D Printing Support, Data Analysis & Documentation
3	Shashank M	Prototype Design, 3D Printing, Mechanical Testing & Experimental Setup

Academic Details

Student Name	Program	Department	Status
Hithali Dinesh	B.E.	Electronics and Communication Engineering	Currently in Final Year
Bhoomika B K	B.E.	Information Science and Engineering	Currently in Final Year
Shashank M	B.E.	Mechanical Engineering	Currently in Final Year

Institution

College: Malnad College of Engineering, Hassan

Project Duration

Dates: 2025 – 2026

Mentor

Name: Dr. Shashank Lingappa M, Assistant Professor, Mechanical Engineering, Malnad College of Engineering, Hassan

Funding

Grant Approved: ₹2,00,000 (2 Lakhs)

Section 2: Visual Assets (High Resolution Requirements)

Student / Team Profile Photo


Hitali Dinesh


Bhoomika B K


Shashank M

Project Photo

Section 3: Narratives

The Hook

"Exploring lightweight 3D printed composite implants as a cost-effective and customizable alternative to conventional metallic orthopaedic implants."

Problem Statement

Conventional orthopaedic implants are primarily manufactured using metals such as titanium and stainless steel due to their high mechanical strength and durability. However, these materials present several limitations including stress shielding, corrosion, and potential metal ion release inside the human body.

The mismatch in stiffness between metal implants and natural bone can lead to bone resorption and implant loosening over time. Additionally, traditional manufacturing processes are expensive and do not allow easy customisation for patient-specific anatomical requirements.

With the advancement of additive manufacturing technologies, particularly 3D printing, it is now possible to fabricate customised implants with complex geometries and porous structures. Composite materials such as Onyx, Carbon Fiber, and Kevlar offer promising alternatives due to their lightweight properties, strength, and cost-effectiveness.

Proposed Solution and Methodology

The study begins with identifying orthopaedic applications such as fracture fixation plates, bone screws, and joint replacement components. Materials including Onyx, Carbon Fiber, and Kevlar composites are selected based on properties such as mechanical strength, density, corrosion resistance, and manufacturability.

A CAD model of the implant is created and fabricated using Fused Deposition Modelling (FDM) based 3D printing. The printed prototypes are then subjected to mechanical characterisation tests including tensile testing and compression testing. The results are analysed and compared with traditional implant materials such as titanium and stainless steel to evaluate feasibility.

Key Findings and Results

Carbon fiber reinforced composites showed high stiffness while maintaining low weight. Composite materials demonstrated improved strength-to-weight efficiency compared to traditional metallic implants.

The use of FDM technology reduced manufacturing cost and material wastage, making the process more economical.

Fiber orientation significantly influenced tensile strength and structural performance. The results indicate that fiber-reinforced composite materials fabricated using 3D printing have promising potential for lightweight orthopaedic implant applications.

The following table compares key parameters between traditional metallic implants and the proposed 3D printed composite implants:

Parameter	Traditional Metallic Implants	3D Printed Composite Implants
Materials	Titanium, Stainless Steel	Onyx, Carbon Fiber, Kevlar
Weight	Heavy	Lightweight
Customisation	Limited; standard sizes	Highly customisable; patient-specific
Manufacturing Cost	High	Lower (reduced wastage via FDM)
Stress Shielding Risk	High (stiffness mismatch with bone)	Lower (tunable stiffness)
Corrosion Risk	Present (metal ion release)	Minimal
Fabrication Complexity	Complex tooling required	Direct from CAD via 3D printing

Future Scope and Next Steps

Future work can focus on advanced mechanical validation and biocompatibility testing of composite implants. Integration of medical imaging technologies such as CT and MRI can enable patient-specific implant design.

Optimisation of fiber orientation, internal infill structures, and hybrid composite materials can further improve strength and durability. With further research, 3D printed composite implants could become a cost-effective alternative for next-generation orthopaedic treatments.