



## Computational Analysis of Hip Replacement Implant

### Project Objectives

The primary objectives of this project were:

- Modeling a hip replacement implant.
- Exploring various modifications of design and testing its performance with different materials.
- Analysis of designs on the basis of chemical and mechanical performance.

### Introduction

Medical implants are devices or tissues that are placed inside or on the surface of the body. Many implants are prosthetics, intended to replace missing body parts. Other implants deliver medication, monitor body functions, or provide support to organs and tissues.

- The project aims to design, analyze, modify, and evaluate hip replacement implants.
- The project is a collaboration between Clutch and Catalyst to explore the interdisciplinary fields of mechanical and chemical engineering in computational biomechanics and biomedical engineering.

### Theory

The design of body implants and its analysis is a very complex process.

Body implants do not have a particular set standard geometry and usually are structurally similar to bones. It can therefore be studied for different structural modifications and also provides opportunities for varied material experimentation.

Hip Implants being one of the main body implants used in the current day scenario. It provides an opportunity for modifications and analysis.

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### Methodology/Procedure

The project was broken down into the following steps:

- Creation of multiple designs of a hip replacement implant using the Fusion 360 package.
- Conducting material and structural analysis of the hip replacement implant using Ansys Structural.
- Reviewing Research Papers to understand the degradation and find the governing equations.

### Project Outcomes

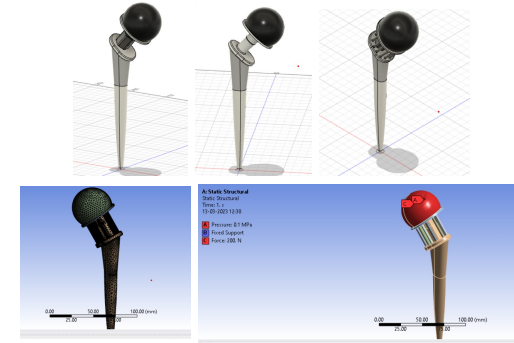
Through the course of the project,

- Hip implants designs were satisfactorily understood and designed.
- Structural analysis was conducted to understand the effect of different materials that can be used for construction of hip implants.
- Softwares such as Fusion360 and Ansys Structural were learnt and applied to construct and study the implant.

### Results

- The industrial in-use hip implant design was replicated to act as the reference design.
- Five structural modifications were performed and later analyzed for mechanical and structural stability using Ansys structural
- Review of research papers related to chemical degradation of implants was conducted to understand the chemical behavior of implants in the body and its interactions with the body fluids.

### Figures/Block Diagrams



$$-D \frac{\partial c}{\partial x} = \beta(c - c_{env})$$

### Project Relevance

The risks of medical implants include surgical risks during placement or removal, infection, and implant failure. Furthermore, chemical degradation is important as increased metal ion concentrations can have a negative effect on bones and muscles.

The field of computational biomechanics and biomedical engineering is one of the very less explored fields but can be regarded as one of the most important fields.

### Conclusion & Future Scope

The construction and application of hip implants were studied and analyzed. Future scope of the project:

- Model the chemical degradation of Hip implant using simulation softwares such as COMSOL.
- Manufacture of implants in a more cost-effective manner.