



Project Proposal for Ph.D.

(will be assigned by SIRe)

Project Details	
Project Title	Design and development of Metal-metal composite based auxetic open cell lattices for Biomedical Applications
Project Summary (Minimum 500 and maximum 2000 characters)	Auxetic lattices possess negative Poisson's ratio which can expand laterally when axially stretched under tensile force. Many parts of the body, such as muscles, ligament tissues, vascular tissues, skin, and bone tissues show characteristics of negative Poisson's ratio, so auxetic structures have been used for tissue engineering research to replace the damaged tissues. In addition, auxetic structures have been used for bio-prostheses, stents, hip stems, and surgical screws because of their optimized compressive strength, shear stiffness, and elastic modulus. The recent advancement of new manufacturing technologies, such as additive manufacturing (AM) or 3D printing, has shown prospective results aimed at producing 3D complex structures precisely by layer-by-layer deposition of materials. It accumulates material layer to create a 3D structure by using digital data from computer-aided design (CAD) software or 3D scanners. Since AM can freely tune an internal architecture and external structure, it is used for the manufacturing of the open cell lattices for tissue engineering and medical devices. 3D printers now have the capability to create multimaterial systems with performance improvements in user definable locations. This means throughout a single component, properties like hardness, corrosion resistance, and environmental adaptation can be defined in areas that require it the most. These new processes allow for exciting multifunctional parts to be built that were never possible through traditional, single material AM processes. Multi-material 3D printers are used to manufacture metal-metal composite auxetic lattices. Moreover, available studies have reported the characteristics of polymer based multi-material lattices and no study has investigated the behavior of metal-metal composite auxetic lattices. The aim of this project is to design novel multi-material auxetic lattices using topology optimization and manufacture the metal-metal composite lattices by additive manufacturing. Furthermore, these can also be combined with the conventional lattices to generate a hybrid implant which decrease the chance of boneimplant interface failure.

Ph.D. Supervisors			
Role	Faculty	Academic Unit in IITD/Institute/University	Email ID (Official)
Supervisor 1	Prof. Dinesh Kalyanasundaram	Center for Biomedical Engineering	dineshk@cbme.iitd.ac.in
Supervisor 2	Prof. Devendra Kr. Dubey	Mechanical Engineering	dkdubey@mech.iitd.ac.in

Project requirements (Student qualifications, experience required, etc)
- Candidate must have a bachelor's degree or masters in mechanical engineering and a valid gate score. - Candidate must have prior experience in finite element modeling, mechanical characterization and 3D printing.

Source of fellowship/funding

(CSIR/UGC/DBT/ICMR/ICAR/NEET-PG/DST-INSPIRE/IRD/FITT Project details, if any)

Institute funding (from CBME)

Role of Faculty Members involved:

Dr. Dinesh Kalyanasundaram is an expert in biomechanics, manufacturing, and characterization of the lattices and orthopedic implants.

Dr. Devendra Kr. Dubey expertise is in nano-mechanics, computational materials science, and finite element modeling.