Postgraduate Certificate in Biofabrication Fabrication

Computational Modeling in Biofabrication

Additive manufacturing (AM): A process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies.

Bio-inks: Materials used in biofabrication that contain living cells, biomaterials, and/or bioactive molecules.

Biofabrication: The use of automated systems to create biological structures in a controlled manner, with applications in tissue engineering, regenerative medicine, and drug discovery.

Biological fabrication: A subfield of biofabrication that involves using living cells, microorganisms, or enzymes to create functional biological structures, such as tissues and organs.

Cell-laden hydrogel: A hydrogel that contains living cells, used as a bio-ink in biofabrication.

Computational modeling: The use of mathematical and computational approaches to simulate and predict the behavior of complex systems, such as those found in biofabrication.

Digital fabrication: The process of creating physical objects from digital designs, including additive manufacturing, subtractive manufacturing, and other automated fabrication techniques.

Fabrication: The process of creating physical objects from raw materials, including both traditional and digital techniques.

Hydrogel: A cross-linked polymer network that can absorb and retain large amounts of water, used as a bio-ink in biofabrication.

Laser-assisted bioprinting (LaBP): A biofabrication technique that uses a laser to selectively transfer cells and biomaterials onto a substrate, creating complex three-dimensional structures.

Microextrusion: A biofabrication technique that uses a computer-controlled syringe to deposit bio-inks in a layer-by-layer manner, creating three-dimensional structures.

Scaffold: A temporary support structure used in tissue engineering to provide a framework for cells to grow and differentiate.

Stereolithography (SLA): A type of additive manufacturing that uses a laser to selectively cure a photosensitive resin, creating three-dimensional objects.

Subtractive manufacturing: A manufacturing technique that involves removing material from a solid block to create a desired shape, as opposed to adding material, as in additive manufacturing.

Tissue engineering: The use of cells, biomaterials, and engineering principles to create functional tissue substitutes for medical applications.

Three-dimensional (3D) bioprinting: A biofabrication technique that uses 3D printing technology to create complex three-dimensional structures from bio-inks, including cells, biomaterials, and bioactive molecules.

Two-dimensional (2D) bioprinting: A biofabrication technique that uses 2D printing technology to create planar structures from bio-inks, including cells, biomaterials, and bioactive molecules.

Vat photopolymerization: A type of additive manufacturing that uses a vat of photosensitive resin and a light source to selectively cure the resin, creating three-dimensional objects.

Bioprinting: A subset of biofabrication that involves using 3D printing technology to create complex three-dimensional structures from bio-inks, including cells, biomaterials, and bioactive molecules.

Biofabrication simulation: The use of computational models to simulate and predict the behavior of biofabrication processes, including the interactions between bio-inks, scaffolds, and cells.

Biological systems modeling: The use of mathematical and computational approaches to simulate and predict the behavior of biological systems, such as those found in biofabrication.

Computer-aided design (CAD): The use of computer software to create, modify, and analyze designs for manufacturing and engineering applications.

Computer-aided manufacturing (CAM): The use of computer software to control and automate manufacturing processes, including additive manufacturing and digital fabrication.

Digital twin: A virtual model of a physical object or system, used for simulation, prediction, and optimization.

Finite element analysis (FEA): A computational modeling technique used to predict the behavior of structures and systems under various loads and conditions.

Multi-material biofabrication: The use of multiple bio-inks and fabrication techniques to create complex, multi-material structures in biofabrication.

Multi-physics simulation: The use of computational models to simulate and predict the behavior of systems that involve multiple physical phenomena, such as fluid dynamics, heat transfer, and structural mechanics.

Parametric design: A design approach that uses mathematical relationships to create flexible, adaptable designs, often used in combination with computer-aided design and manufacturing.

Rheology: The study of the flow and deformation of matter, used to characterize the properties of bio-inks and other materials used in biofabrication.

Topology optimization: A computational modeling technique used to optimize the distribution of materials in a structure for maximum performance, often used in combination with additive manufacturing.

Bioprinting process: A series of steps involved in creating a three-dimensional structure using biofabrication technology, including design, material preparation, fabrication, and post-processing.

Bio-ink preparation: The process of mixing and formulating bio-inks, including cells, biomaterials, and bioactive molecules, for use in biofabrication.

Cell viability: The percentage of living cells in a population, used as a measure of the effectiveness of biofabrication processes.

Computational fluid dynamics (CFD): A computational modeling technique used to simulate and predict the behavior of fluids, such as those found in biofabrication processes.

Fabrication post-processing: The process of finishing and preparing a three-dimensional structure after fabrication, including cleaning, sterilization, and functionalization.

Material characterization: The process of measuring and analyzing the properties of materials used in biofabrication, including rheology, biocompatibility, and printability.

Precision medicine: A medical approach that takes into account individual genetic, environmental, and lifestyle factors to create personalized treatments, often using biofabrication and tissue engineering techniques.

Scaffold design: The process of creating a three-dimensional structure that provides a framework for cells to grow and differentiate, often using computer-aided design and manufacturing techniques.

Tissue maturation: The process of allowing a three-dimensional structure to develop and mature over time, often using culture conditions and bioreactors.

Biofabrication challenges: The technical, ethical, and regulatory issues that arise in the development and use of biofabrication technology, including cell sourcing, biocompatibility, and scale-up.

Biofabrication limitations: The technical and practical limitations of biofabrication technology, including resolution, speed, and cost.

Biofabrication opportunities: The potential applications and benefits of biofabrication technology, including personalized medicine, regenerative medicine, and drug discovery.

Computational modeling challenges: The technical, ethical, and regulatory issues that arise in the development and use of computational modeling in biofabrication, including accuracy, validation, and interpretation.

Computational modeling limitations: The technical and practical limitations of computational modeling in biofabrication, including complexity, uncertainty, and computational resources.

Computational modeling opportunities: The potential applications and benefits of computational modeling in biofabrication, including design optimization, process control, and predictive maintenance.

Digital fabrication challenges: The technical, ethical, and regulatory issues that arise in the development and use of digital fabrication technology, including automation, standardization, and cybersecurity.

Digital fabrication limitations: The technical and practical limitations of digital fabrication technology, including resolution, speed, and cost.

Digital fabrication opportunities: The potential applications and benefits of digital fabrication technology, including mass customization, rapid prototyping, and distributed manufacturing.