**2024 SCUT Global Engineering Summer Program**

**课程一：Advanced Materials of Soft Matter and Biomedicine**

**模块1.Tissue Engineering and Artificial Organ**

This course is aimed at covering the important multi-disciplinary research field of tissue engineering and artificial organ. The limited supply of donor tissues and organs has become a major medical challenge that compromises the treatment outcome of many diseases and injuries. This course will cover the key elements of tissue engineering paradigm including the therapeutic cells, biomaterial scaffold, inductive factors, and recent developments and challenges in the field of tissue engineering and artificial organs. Specific topics including stem cells, extracellular matrix, biomimetic biomaterial design, morphogens, controlled delivery, and mechanotransduction will be discussed in this course.

**模块2.Advanced Materials in Biomedical Imaging and Diagnostics: Introduction, Principles and Applications**

This course provides an introduction of different biomaterials that underpin modern biomedical imaging and diagnostic applications. The course will cover state-of-the-art biomedical imaging and diagnostic technologies that are currently applied clinically, in clinical trials or under active preclinical development, including but not limited to optical imaging, ultrasound imaging, photoacoustic imaging, MRI, CT, nuclear imaging, point-of-care diagnostics, synthetic biomarkers, etc. Attendees will have a basic understanding of the principles associated with each technology and how material science was leveraged to solve healthcare challenges.

**模块3.Biomaterials**

This course focuses on the structure of biomaterials and the formation of material structure, and discusses the basic theoretical issues of biomaterials science and engineering from the perspective of physical chemistry. Describes the fundamentals of various materials related to biomedical engineering, including metal, inorganic non-metal and organic polymer materials, in terms of composition, structure, chemical and physical properties. Introduces thermodynamic functions and laws governing equilibrium properties, relating macroscopic behavior to atomistic and molecular models of materials. Introduces structure of crystalline and noncrystalline states, symmetry and tensor properties of materials, point, line, and surface imperfections in materials, materials phenomena such as phase transformations, multiphase equilibria, chemical reactions, mechanical property, synthesis and application of polymeric materials. Through studying of the course, Student will master the basic theories of material structures, the relationship between materials structures and materials properties, materials thermodynamics and materials kinetic.

**模块4.Optics of Emergent Soft Matter**

Soft matter is a special category with high flexibility to respond to and control light fields. From the big success in many industries like display, light modulator, and the like, we now face new challenges in soft matter optics and photonics. In this course, we aim to clarify emerging material science and technology in modern optics of soft matters (e.g., polymer, liquid crystal, and supramolecular systems), as well as a brief introduction to fundamental physics in optics. In addition to lectures, the students will be able to enjoy related experiments during the class, which would be intuitive and straightforward.

**模块5.Hybrid Techniques of Emergent Soft Matter**

Soft matter are usually defined as materials made of mesoscopic entities, sensitive to thermal fluctuations and to weak perturbations. Archetypal examples are colloids, polymers, amphiphiles, liquid crystals, foams. The importance of soft materials in everyday commodity products, as well as in technological applications, is enormous. The objectives of the course are to stimulate the students’ interest in material and technique development based on soft matter materials. In this course, we will have three or four professors to give individual lectures. They will introduce the emergent technologies of soft matter, with polymers as the representative, involving: affordable and clean energy from polymer solar cells, energy storage technologies with polymers, gas separation and water cleaning with porous materials, and polymers supported new display technologies. Students learn via lecture, tutorial, and group discussion.

**模块6.Biomimics of Emergent Soft Matter**

Biomimetics in soft materials is an innovative field of study where scientists and engineers draw inspiration from the natural world to design and fabricate materials that replicate the remarkable properties of biological tissues and organisms. This interdisciplinary approach leverages the principles of biology, chemistry, materials science, and engineering to create soft materials with functionalities that often surpass conventional synthetics. In this course, professors will talk about developing soft materials with uses ranging from biomedical applications and advanced robotics to responsive materials and beyond. The exploration of biomimetics in soft materials not only holds the promise for technological breakthroughs but also offers profound insights into the symbiosis between synthetic and biological systems.

**课程二：Artificial Intelligence and High-end Manufacture**

**模块1.Large Language Models and Prompt Engineering**

This course aims to briefly introduce the recently popular Large Language Model (LLM), and how to teach it to work in the way we want using Prompt Engineering. The prompt engineering is to generate a set of prompts (i.e., instructions) designed specifically for LLMs so they can perform specific tasks that they have never seen before. For instance, teach LLMs to become a poet that can produce poetry of given topics, or a writer that can generate reports given a set of keywords. In this course, we will learn how to design effective prompts by looking into the typical properties of LLMs, with exercises provided.

**模块2.Soft Robotics**

This innovative summer course in Soft Robotics offers a comprehensive introduction to the exciting and rapidly developing field of soft robotics. Over the course of 16 hours, participants will delve into the design, modeling, and analysis of typical soft actuators, such as pneumatic artificial muscles, gaining a thorough understanding of their unique properties and capabilities.

The course also explores the wide range of applications for soft robots in various fields, including biomedicine, industrial automation, service robotics, and more. Through a combination of lectures, hands-on laboratory sessions, and project-oriented learning, students will develop the skills necessary to design and create their own soft robots, including soft grippers and mobile platforms.

With a focus on practical application and hands-on experience, this course is perfect for students interested in robotics, mechatronics, materials science, and related fields. By the end of the course, participants will have a basic understanding of the fundamental principles and practical applications of soft robotics, positioning them well for further studies or careers in this exciting and emerging field.

**模块3.Smart Factory**

This course offers a dynamic exploration of how interconnected factories, driven by the Internet of Things (IoT), artificial intelligence (AI), and data analytics, are reshaping the manufacturing landscape. We'll explore the integration of advanced robotics, the transformative power of AI and machine learning in production, and the pivotal role of big data in operational optimization. Additionally, we will delve into the innovative realms of sustainable manufacturing practices, ensuring a comprehensive understanding of how these technologies contribute to efficiency and environmental sustainability. The course also addresses crucial aspects of cybersecurity and ethical considerations in automated systems. Through a blend of theoretical knowledge and practical insights, including case studies and industry expert interactions, this course is designed to ignite your curiosity and equip you with a deep understanding of the future of manufacturing.

**模块4.3D Vision Intelligence**

3D Visual Intelligence is a course designed for students with interests in computer vision and deep learning. This course emphasizes collaboration with enterprises, and as a result, a portion of the course content will be sourced from Orbbec Technology Co., Ltd., and the OpenCV community. Throughout the program, students will gain a solid understanding of fundamental concepts in artificial intelligence and 3D vision, and learn how to apply this knowledge to solve practical engineering problems. Key topics covered in this course include basic concepts of artificial intelligence and 3D vision, 3D visual data representation and visualization, 3D imaging principles, 3D rendering and visualization, visual recognition based on point cloud, and synchronous localization and mapping algorithms.

**模块5.Metaverse Introduction and Practice**

Metaverse Introduction and Practice is a course tailored for students intrigued by metaverse-related technologies. The metaverse entails the virtualization and digitization of the real world, leading to significant transformations in content production and user experiences. This course uniquely blends theory with hands-on practice, incorporating NVIDIA Omniverse-related software systems to provide a solid foundation for experimentation. Throughout the curriculum, students will delve into key areas such as 3D engines, digital twins, enabling the conversion of theoretical knowledge into practical skills. The course is designed to empower students in applying these techniques to solve real engineering problems. Major topics covered include AIGC and the metaverse, blockchain, human-computer interaction, 3D engines, digital twins.

**模块6.Low Carbon Smart Energy（未来技术）**

Low Carbon Smart Energy is a course designed for students interested in machine learning and power systems. This course emphasizes the application of machine learning in the power market and energy field, and provides rich experiments and video cases to enhance students' participation and cultivate students' innovative thinking and problem-solving ability in the energy field. Throughout the course cycle, students will develop a solid understanding of the basic concepts of machine learning and power systems, and learn how to apply what they have learned to practical engineering problems. The main content of this course includes the basic concepts of low-carbon smart energy, the principles and technologies of energy management, the operation mechanism of electricity market and related policies, and the specific application of machine learning in the field of energy management.