MECH 500 – Special Topics in Mechanical Engineering

Bionic Implants & Devices

This course familiarises students with trends in BIONIC implants & devices. Unlike conventional biomaterials and implants such as heart valves and artificial hips, bionic devices are able to replicate both the mechanical structure and biological function of the damaged and diseased organs they replace, often by interacting with the human body in a bidirectional fashion. Bionic implants are a relatively new and exciting field of research, and include artificial muscles, neural electrodes, artificial mechanoactive cartilage, implantable artificial heart, bioresponsive drug delivery systems, biofunctionalised implant surfaces, among others.

This one-of-a-kind course provides a broad overview of the emerging field of bionic implants by drawing in on a range of disciplines: chemistry, physiology, microelectronics, biomechanics, mechanotronics and computation. The course will combine material culled from leading journal papers with actual clinical case studies.

Briefly, the course will cover the following:

- **Basic Notions in Medical Devices**: Biomaterials, biocompatibility, bioelectricity, immune response, conventional tissue and organ replacements
- **Functional Biomaterials for Bionic Implants**: shape-memory alloys, foams, hydrogels, self-healing materials, functionally graded materials, micro and nano-structured materials etc.
- **Artificial Muscles and Neuroprosthetics**: Basic neuroprosthetic device design, bioelectrodes, electroactive polymers, polyelectrolytes, conducting polymer interfaces, bio-mems and nems, cochlear and vestibular implants.
- **Implant Surfaces and Interfaces**: Immune response, micro and nano-patterning of implant surface, biorecognisable interfaces, drug-eluting surfaces, porosity.
- **Functional Tissue Engineering and Bioartificial Organs**: Designing porous scaffolds, scaffold "patterning", mathematical modelling of tissue growth on scaffolds.
- **Bioactive and Bioresponsive Implants**: Controlled drug delivery systems, heart "blankets", artificial liver and pancreas.
- **Brain-Machine Interface and Cortical Prosthetics**: Overview of the Central Nervous System, tapping into primary motor cortex to generate movement, visual cortex to restore vision. Microelectrode arrays, non-invasive methods of capturing brain signals, neuromorphic chips.
- **Implantable Devices for Minimally-Invasive Surgery**: Stents, guidewires based on shape-memory alloys, thermosetting suture materials, drug-eluting devices.

For more information on the course please contact Sumitra Rajagopalan at sumitra.rajagopalan@polymtl.ca