ENGINEERING PROGRAMS
Biomedical, Civil, Computer, Electrical, Mechanical, Software
2\textsuperscript{ND} \textsc{Year}: \textsc{Your Program}!

Dr. LillAnne Jackson

Associate Dean, Undergraduate Programs
Program Declaration

https://servicecatalog. engr.uvic.ca/students/declare/

- You declare: now – April 30
- Requires 12 (relevant) units
- No grade less than C
- After spring grades arrive (in May/June)
- Students moved into programs
- Email confirms your program
So, which program is for you??
Presenters

Biomedical Engineering
Dr. Stephanie Willerth

Civil Engineering
Dr. Christopher Kennedy

Electrical & Computer Engineering
Dr. Michael McGuire

Mechanical Engineering
Dr. Yang Shi

Software Engineering
Dr. Stephen Neville
What is Biomedical Engineering?

→ Biomedical Engineers use their training/expertise to analyze problems in biology and medicine, and to design/create technology that provides an overall enhancement of health care and medicine.

→ These technologies may include:
  - Bioinstrumentation & Biosensors
  - Biomaterials & Tissue Engineering
  - Biomechanics
  - Clinical Engineering
  - Medical Implants
  - Medical Imaging
  - Medical Devices & Equipment
  - Rehabilitation Engineering
  - Others . . .
Three important components of a biomedical engineer:

1. Firm foundation in engineering (science, mathematics, design)
2. Working knowledge of human biology
3. An understanding of medicine and clinical practice
Examples of Biomedical Engineering Activities:

- **Biomaterials & Tissue Eng.**
  - Detection of Biomarkers (Proteins, Molecules, abnormal cells, etc.)

- **Prosthesis and Artificial Limbs**
  - Vibrating nanowires, allow for early cancer detection by weighing disease molecules.

- **Medical Imaging such as:**
  - MRI, Ultrasound, or CT (X-Ray).
Needs and Demands for Biomedical Engineering

→ Growing demand for Biomedical Engineers in Canada, and worldwide.

→ BME is projected as a fast growing profession by various sources [1-2].

→ Search/Google: “Canada Biomedical Engineering Jobs”

Needs and Demands for Biomedical Engineering

- Biomedical engineering encompasses all areas of the public and private sectors involved with medical, biological and human healthcare.

- Biomedical engineers are needed in the medical technology industry, hospitals and medical institutions, and various research facilities, to design, develop and evaluate technologies aimed at medicine and healthcare.
Needs and Demands for Biomedical Engineering: Examples:

- Design and development of better healthcare equipment, including performance testing, and establish safety standards for new devices.
- Health care management and operations
- Medical equipment specification, maintenance and operations (e.g. Royal Jubilee Hospital, or medical facilities)
- Medical equipment certification and analysis (e.g. CSA, UL, or private).
- Medical devices industry (sales, distribution and marketing).
UVic Biomedical Engineering Program:

→ BME engineering is a combination of BME, MECH, ELEC and CSC courses.
→ Unique BME courses at the 2nd and 3rd Year Level:

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BME 200</td>
<td>Learn about molecular and cellular physiology from an</td>
</tr>
<tr>
<td></td>
<td>engineering perspective</td>
</tr>
<tr>
<td>BME 201</td>
<td>Learn about human physiology and the major organ systems</td>
</tr>
<tr>
<td>CHEM 231</td>
<td>Study the fundamentals of organic chemistry</td>
</tr>
<tr>
<td>BIOC 299</td>
<td>Study the fundamentals of biochemistry and microbiology</td>
</tr>
<tr>
<td>BME 335</td>
<td>Learn about biosensors and instrumentation</td>
</tr>
<tr>
<td>BME 350</td>
<td>Design a biomedical device/product in a team-based environment</td>
</tr>
</tbody>
</table>
UVic Biomedical Engineering Program:

The 4th Year Level - Electives:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BME 403</td>
<td>Medical Image Processing: Learn about image processing and applications to CT, X-ray, MRI and ultrasound</td>
</tr>
<tr>
<td>BME 434</td>
<td>Biophotonics: Optics and application to biology and photobiology</td>
</tr>
<tr>
<td>BME 481</td>
<td>Biomaterials and Tissue Engineering.</td>
</tr>
<tr>
<td>MECH 450</td>
<td>Human Biomechanics</td>
</tr>
<tr>
<td>MECH 483</td>
<td>Mechanics &amp; Energy Conversion in Living Cells.</td>
</tr>
<tr>
<td>PHYS 432</td>
<td>Biomedical Physics</td>
</tr>
<tr>
<td>BME 499</td>
<td>Capstone Design: biomedical device/system in a team-based environment</td>
</tr>
</tbody>
</table>
UVic Biomedical Engineering Program, UG Students:

→ On campus Co-op opportunities with research laboratories in:
  → - Medical device development
  → - Tissue engineering
  → - Medical imaging

→ BioDev student team, [http://www.uvicbiodev.com](http://www.uvicbiodev.com)

→ Victoria Hand Project, [http://www.victoriahandproject.com](http://www.victoriahandproject.com)

→ 4th year Thesis and Honor’s Thesis research work on biomedical projects

→ On campus volunteer work with research groups
UVic Student Teams for All Engineering Students:

- EcoSat project, building a microsatellite
- Formula SAE, race car team
- Autonomous underwater vehicle (AUV) team
- UVic Aero unmanned aerial vehicle (UAV) team at Victoria Airport
- UVic EcoCar, Canada-US competition, hybrid vehicle
- Computer programming competitions
Welcome to Canada's Green Civil Engineering Program
Green Civil Engineering is managing, designing, constructing and maintaining the built and natural environment, using technologies and techniques that provide services to society, while working within the carrying capacity of local ecosystems and the planet.
Civil Engineering

Advanced Buildings

Green Buildings

Sustainable City Planning
Civil Engineering

Bridges (New Port Mann Bridge)

Transportation and Roads

Power Infrastructure and Dams
Civil Engineering

Building Science

Water Resource Engineering

Environmental Monitoring and Modelling
# Jobs in Civil Engineering

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>BC</td>
<td>214</td>
<td>667</td>
</tr>
<tr>
<td>Alberta</td>
<td>239</td>
<td>427</td>
</tr>
<tr>
<td>Ontario</td>
<td>1022</td>
<td>726</td>
</tr>
<tr>
<td>Quebec</td>
<td>886</td>
<td>413</td>
</tr>
</tbody>
</table>
## Top Co-op Employers

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCL Constructors Inc</td>
<td>19</td>
</tr>
<tr>
<td>National Defence and the Canadian Forces (DND)</td>
<td>16</td>
</tr>
<tr>
<td>University of Victoria</td>
<td>16</td>
</tr>
<tr>
<td>Knappett Projects Inc</td>
<td>10</td>
</tr>
<tr>
<td>McElhanney</td>
<td>8</td>
</tr>
<tr>
<td>Work Term Challenge</td>
<td>8</td>
</tr>
<tr>
<td>Teck Ltd</td>
<td>7</td>
</tr>
<tr>
<td>BC Transit</td>
<td>7</td>
</tr>
<tr>
<td>City of Edmonton</td>
<td>7</td>
</tr>
<tr>
<td>BC Ministry of Transportation and Infrastructure</td>
<td>7</td>
</tr>
<tr>
<td>Graham</td>
<td>7</td>
</tr>
<tr>
<td>Defence Construction Canada</td>
<td>6</td>
</tr>
<tr>
<td>Herold Engineering Ltd</td>
<td>6</td>
</tr>
<tr>
<td>Flatiron Construction Corp</td>
<td>5</td>
</tr>
<tr>
<td>BC Hydro</td>
<td>5</td>
</tr>
<tr>
<td>Entrepreneurial Work Term</td>
<td>5</td>
</tr>
<tr>
<td>Kiewit Corporation</td>
<td>5</td>
</tr>
</tbody>
</table>
Climate Change
Cities
What do electrical engineers do?

• Electrical Engineering:
  – Work with applications of electromagnetic phenomena.
What do computer engineers do?

• Computer Engineering:
  – Work on interactions between software code and underlying computing hardware.
The Future Car…

Do you really want to drive?

- Electrical and computer engineers develop:
  - Reliable controllers and sensors.
  - Control algorithms
Electrical Energy Systems

- Vehicle power and drive systems
- Power generation, transport, and storage.
- “Smart Grid” power distribution

"Formula e" Electric Racing Car (8668735136).jpg" by David Merrett is licensed under CC BY 2.0
"OPG-7-Gomberg-Turbine-001.jpg" by Mdf is licensed under CC BY-SA 3.0
"28022011133.JPG" by Stefan Kiesa is licensed under FAL 1.3
Digital Signal Processing

- Medical Imaging
- 3D modelling and printing
- Radio astronomy
- Audio processing

"Apikal4D.gif" by Kjetil Lenes is licensed under CC BY-SA 3.0
Electromagnetics and Photonics

- Single Molecule sensing
  - More accurate tests with smaller samples
  - Embedded medical sensors.
- Next Generation Electronics
- Quantum Computers
  - Creating new types of computing devices
Sensor Processing and Control
Career Outlook in ECE

• Fast growing field in Canada & US
  • Low unemployment rate
• Good salaries
  • $60,000 for Bachelor’s
  • $80,000 for Master’s
  • $100,000 for PhD
• Consider a career in ECE…
Mechanical Engineering @ UVic

Exciting Career Path and First Class Training
Innovation and Diversity
- Mechanical Engineers Work on

- Design
- Analysis, Testing & Simulation
- Manufacturing
- Maintenance, Service and Sale
- Research and Development
- Management
- Education

of

Mechanical, Energy; Mechatronics Systems; Software; Electrics and Electric Drive; Smart Grids; Biomedical Appl; Green Building; …
Past, Present and Future of Mechanical Engineering

Serving the Public, Improving Life Standard and Advancing the Frontiers of Discovery

• **Mechanization**
  – Agricultural, Automotive, Aeronautic, Aerospace Applications

• **Automation**
  – Products: Automobile, Aircraft, etc.
  – Design: Computer Software
  – Manufacturing: Robot, CNC, CIM

• **Integration of Tech & Systems**
  – Better Designs/Better Built Products
  – New Materials and Processes
  – Multidisciplinary Studies
    • Renewable Energy
    • Biomedical Engineering
    • Mechatronics & Robots
    • Nano-technology
    • Green Transportation
    • …
On Land

UVic Research & Student Work
In Ocean

UVic Research & Student Work
In Air

UVic Research & Student Work
In Space

UVic Research & Student Work
Fun and Challenging

Modeling – Hybrid Powertrain

Growing – Crystal Material

Machining – Designed Prototype

Cooling - Magnetic Refrigeration

Testing - Electronics

Playing with - UVic EcoCAR
Subjects of Study and Career Paths

- Mechanics
- Mechanical Systems
- Automation - Integration of
  - Mechanical System
  - Computer Control
  - Electronics
  - Robots and Mechatronics
- Computer Design and Analysis Tools
- Energy Systems
- Advanced Manufacturing, Production and Project Planning
- Materials
- Micro-Mechanical System (MMS)
- Biomedical Engineering
- Eng. Law and Business Organization

- Automotive
- Aeronautic and Aerospace
- Marine Applications
- Manufacturing
- Clean Energy Systems
- Construction
- Medical Devices
- Research & Development
- Management
- Education
- etc.
Why Mechanical Engineering?

Glorious Past, Exciting Present and Brilliant Future

• One of the first and well established Engineering Professions
• A profession with the combined knowledge/skills from many different areas
• A wide variety of career opportunities
• Creative thinking and work
• Challenging task
• Intellectual development
• High job satisfaction
• Financial security and prestige
• Professional environment
• A department with exciting research and passionate staffs
• A department that successfully mapped our first class, cutting-edge research into our curriculum and broad co-curricular programs

http://www.uvic.ca/engineering/mechanical/
Difference between software engineering and computer science?

- **Computer science** focuses on foundations of computing including: algorithms, programming languages, theories of computing, artificial intelligence, and hardware design.

- **Software engineering applies** this science to the technical engineering and managerial leadership of large and complex systems.
  - Its foundation is in the **enduring engineering principles** required to support a lifetime of practice amid the rapid evolution of technologies.

http://mse.isri.cmu.edu/software-engineering/web1-why/index.html
Software engineers solve many kinds of problems!

- Create software for earlier tumor detection
- Develop lag-free multiplayer on-line games
- Design faster image-handling in digital cameras
- Improve the security of on-line services
- Assess the safety of flight control software for passenger aircraft
- Develop the next generation of cloud computing

http://www.engineergirl.org/cms/6067.aspx
Cars Run on Code
100-200 mil. lines . ~100 processors . 70% effort in SW

> 50% warranty costs due to SW
Car Security

Steal or disable a car just by calling it on the phone
Health Care Runs on Code
‘s’ medical devices – software-based medical systems
The world runs on code
Opportunities and Risks

Computer-based trading
Smart-power grids
New media and games
Cyber security & warfare
Big Data, Data Analysis, Machine Learning and AI

Software Engineers are trained to responsibly balance opportunities and risk
Careers

- Chief technology officer
- Security analyst
- Project manager
- Designer (e.g., U/X)
- Data Analyst
- Entrepreneur

SEng is one of the fastest growing engineering disciplines globally!
Career Advantages?

- Creative and collaborative work
- Highly paid
- Job security & diversity
- Flexible work
- Broad cross-industry demand
- Ever increasing demand
The SE Program @UVIC

- **Common First Year**
  - (Engineering Fundamentals)

- **Second Year**
  - (SW Eng. Fundamentals incl. testing)

- **Third Year**
  - (Core SWE Knowledge Areas incl. Security Engineering)

- **Fourth Year**
  - (Electives, Specializations)
  - Netw. Sec., Crypto, Practice

Creating T-shaped people

Accredited program: [Canadian Engineering Accreditation Board](http://www.caac.org)
Cyber Physical Systems (CPS)

- Smart systems that encompass computational and physical components, seamlessly integrated and closely interacting to sense the context of the real world
Cyber Physical Systems

Sensors, Actuators Feedback Loops

Context Management

Instrumented Connected

Predictive Analytics
Smart Buildings
Connected Cars
CPS SOCIETAL IMPACT

• Virtually every engineered system is affected by advances in the networked and cloud capabilities of CPS

• Future CPS applications are expected to be more transformative than the IT revolution of the past three decades

Yang Shi, 2015 Craigdarroch Silver Medal for Excellence in Research
University of Victoria
Software dominates all aspects of interconnecting the physical and cyber worlds into composite systems.

Your generation is the one that is going to make this happen!