McMaster University

Integrated Biomedical Engineering & Health Sciences Program

Introduction

TAYLOR DEVET MASC.

PHD. CANDIDATE BIOLOGICAL AND BIOMEDICAL ENGINEERING

MCGILL UNIVERSITY

SHRINERS HOSPITAL FOR CHILDREN

A bit about me…

BEng Electrical and Biomedical Engineering Coop, McMaster (**2018**)

      2015-2017 Venture Engineering and Science

      2014-2018 Welcome Week Rep, Cooc

      2014-2020 TA ENG1D04, ELEC ENG 4BC3, IBIO 1P10, IBIO 4P04

MASc. Biomedical Engineering McMaster (**2020**)
      Development of an electrical stimulation device for bone cells
      Supervisor Dr Greg Wohl

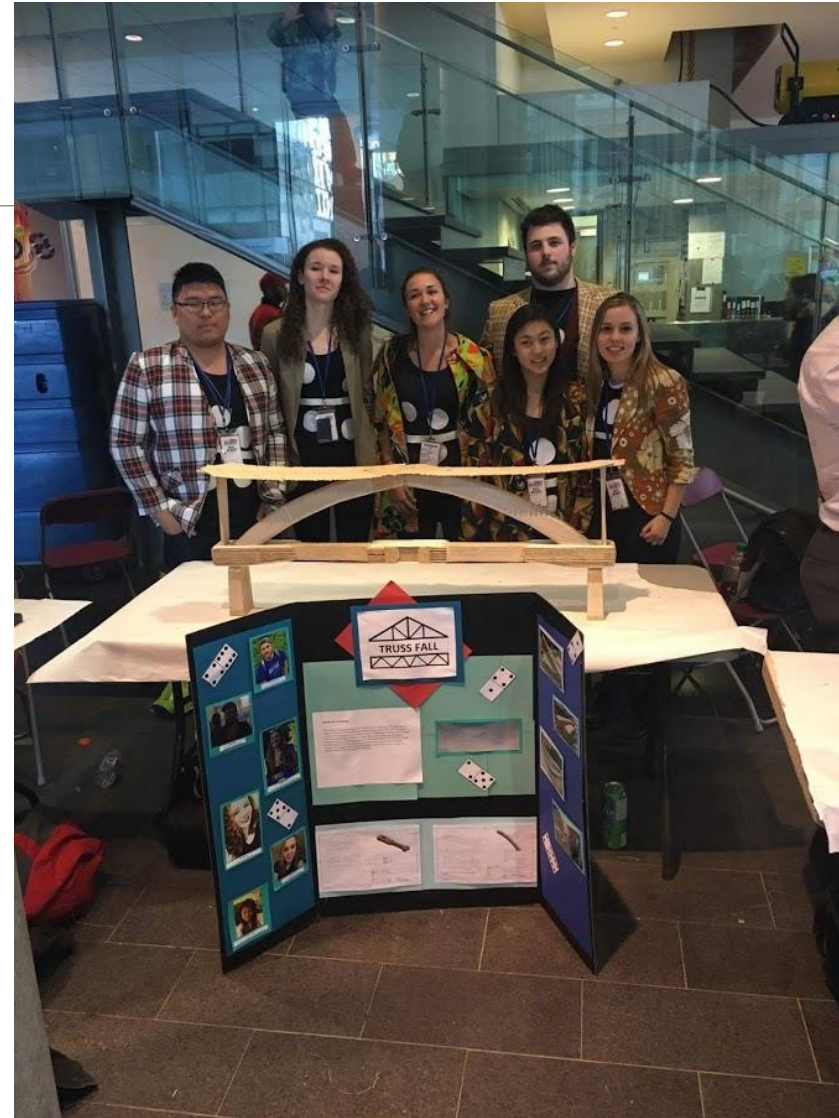**PhD** Biological and Biomedical Engineering McGill (**2021-**)
      Investigating the osteocyte-lacuna-canalicular network
      Spaceflight, Craniosynostosis, and SOST

Revamped Civil Structure: 2019

Troitsky Bridge Building 2016

Contact Information

Email: devett@mcmaster.ca

Campus Office: n/a

Office Hours

Fridays 10:30am - 12:30 noon (Teams)

Teaching Assistants:

Noor Abu Jarad   abujaran@mcmaster.ca

Andrew Lofts   loftsa@mcmaster.ca

Course Content

From the Undergraduate Calendar:

Introduction to experimental design and variance associated with biological systems and analysis of biological data, mathematical and engineering methods for describing and predicting the behaviour of biological systems; statistical models of biological functions;

- Variance within biological systems and measurement systems

- Modelling basics and assumptions

- Types of models and systems

- Machine Learning

Course Objectives

Mathematical approaches to modelling biological systems and the challenges associated with it.

- Understanding biological data
- Statistical significance of models

Linear time invariance (LTI)

- short-time Fourier transform (STFT)
- Wavelets
- PCA/ICA
- Nonlinear dynamics (fractal and chaotic models)

Real life examples

- imaging systems
- physiological recording systems

Course Content

1) Course intro & Introduction to modelling

2) Biostatistical analysis , regression, Experimental design

3) CRD RCBD Post hoc testing

4) Cardiac modelling

5) Pharmacokinetics (1, 2, and 3 compartments), indicator dilution, contrast agents and other tracers used for assessing microvascular and metabolic kinetics.

6) PCA ICA

7) Chronobiology , LTI

8) Fourier, STFT, Wavelets

9) Scaling allometry Chaos and fractals

10) Chaos cont. , phase space , attractors

11) Machine Learning

Course Schedule and Location

One 3hr lecture and one tutorial weekly.

Tutorials: Wednesday.1:30pm-2:20pm   BSB-137

Lectures: Monday .7:00pm–10:00pm   Teams

Textbooks and Recommended Readings

There is no one book to cover all the material for this course. Necessary papers and readings to complement the course material will be posted to the course website as suggested readings. The following texts may be helpful:

- Modeling and Simulation in Medicine and the Life Sciences 2nd Edition – Frank Hoppensteadt, Chasles S.Peskin
- Dynamic Systems, Biology Modeling and Simulation – Joseph DiStefano III
- Biosignal and Medical Image Processing 3rd Edition - John L. Semmlow, Benjamin Griffel
- Physiological Control Systems – Michael C.K. Khoo

- Class notes will be posted on the course website before 12:00noon the day of the lecture: The class website is on Avenue to Learn: http://avenue.mcmaster.ca/

Grading

Individual assignments (4) worth 5% each   20%

      #1 due October 3

      #2 due October 17

      #3 due November 7

      #4 due November 21

Quizzes (12, drop 2)   5%

Group Analysis Project   25%

In-class group presentation

Midterm (October 19-22,)   20%

Final Exam (TBA)   30%

NOTE #1: Assignments are due digitally (i.e. upload to Avenue) at 11:59pm on the due date.

NOTE #2: Late assignments will be deducted 0.01389% per minute. (20% /day)

Assignments (5% Each)

Based on material learned in lectures and tutorials

Programming in <u>Matlab</u> or <u>Python</u>
◦ If you don't have access to a computer to run these, let me know and we can get you access

Individual assignments to be done as an individual effort

Analysis Project (20%)

o project and presentation are done in groups (of up to 4)

o model some form of physiology or physiological response using 2 different methods

o can be disease and/or therapy related

o must choose how to model the data and why an approach is chosen (why appropriate)

o must include proper statistical analysis from multiple subjects

o must include error analysis where appropriate.

o The report should end with interpretations, conclusions, and possible future directions and should be 2000-3000 words (not including figure/table captions or programming code)
  o I.e. should look like a scientific journal

o figures, programming code, etc. must be included

Presentation (5%)

o At the conclusion of your project there will be a presentation day where groups will share their project in breakout rooms

o Grading will be done by the instructor or TA.

oGroup self assessment can be done and submitted to the TA the day after the presentation (optional).

oGroups will be decided upon by the students and submitted to the TA by <u>Tuesday September 17th</u>. Whoever does not get into a group will be randomly assigned into one.

oPresentations will be graded according to: Style, Clarity, Knowledge, Quality, Organization and ability to answer questions. The <u>rubric</u> is on avenue

Analysis Project

Where to get Data??

1). You can acquire it yourself. BUT- please let me know asap if this is what you wish (you will need ethical approval)

2). Download data from a repository:
https://physionet.org/physiobank/physiobank-intro.shtml
https://www.nlm.nih.gov/NIHbmic/nih_data_sharing_repositories.html
https://github.com/meagmohit/EEG-Datasets
https://www.re3data.org
https://lionbridge.ai/datasets/18-free-life-sciences-medical-datasets-for-machine-learning/
https://www.cancerimagingarchive.net/
https://www.kaggle.com/uciml/pima-indians-diabetes-database
https://www.kaggle.com/uciml/breast-cancer-wisconsin-data#data.csv
https://www.kaggle.com/tags/pharmaceutical-industry

Due December 5th.

Instructions: Fill out completely and email to the TA for each assignment and presentation

NOTE: This is an integral part of grading.

NOTE: **This form is optional. Use it if you think a member(s) has not shared in doing the work**

A	YOUR Name:	
	Student #:	
	Assignment:	

B **Peer evaluation of contributions to presentation by my group members**

Fill in the table below with a score indicating the RELATIVE CONTRIBUTION of each member in your group, including yourself. Total of all your scores must equal zero.

The relative contributions should be indicated on a scale of -10 to +10, where negative scores indicate the contribution was below average and positive scores indicate the contribution was above average.

Each assignment and presentation are worth 9% of your total grade. Each point counts as +/- 10% of this (up to a max of +/-100%). So if your group assignment grade is 8/9 and your group members give you an average of -4, your assignment grade is (8/9)-40%x9=4.4/9

If you score anyone's contribution as < -2 or > +2, make sure you justify your score.

NOTE: YOU can't get higher than 9/9 final grade on an assignment!!!

Last name	First name	Relative Contribution
	total	0

C **Justification**

Exams

Midterm Exam: (October 19th -22nd)   20%

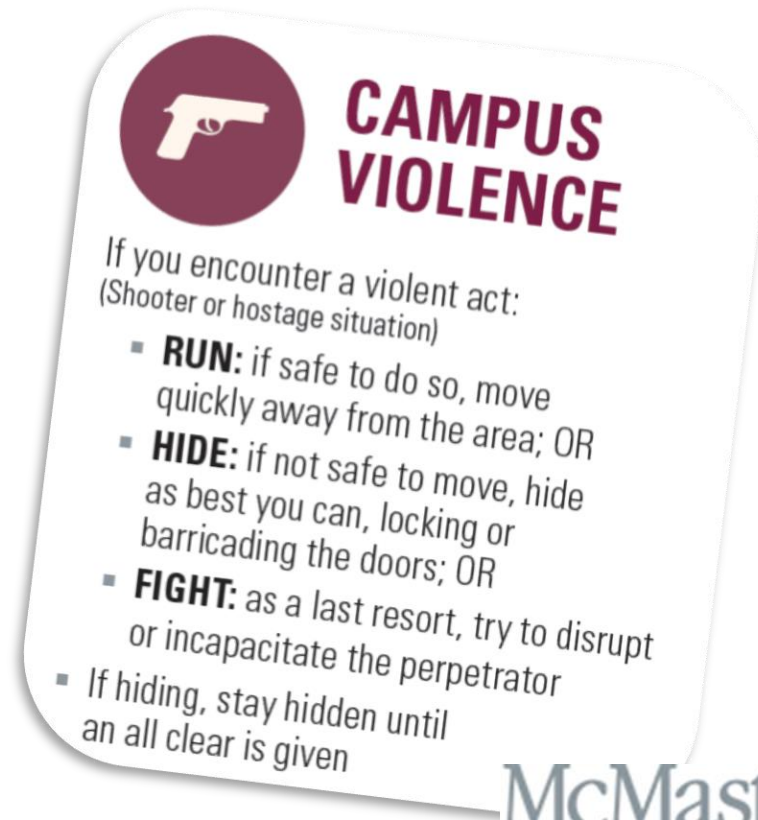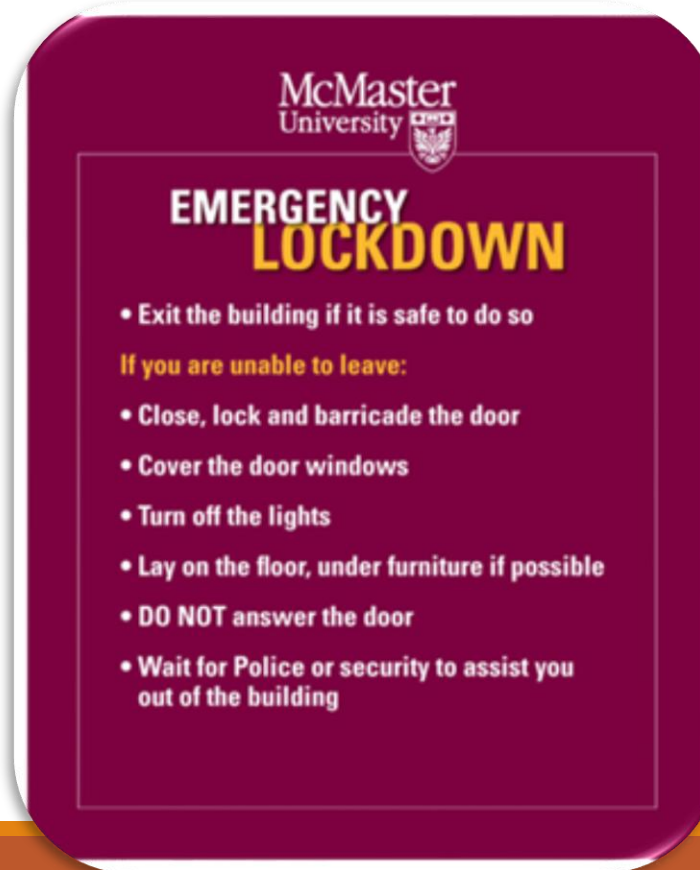Final Exam: Date, TBA   30%

- covers from Midterm onwards

BOTH EXAMS are "OPEN BOOK"

EMERGENCIES ON CAMPUS LOCKDOWN
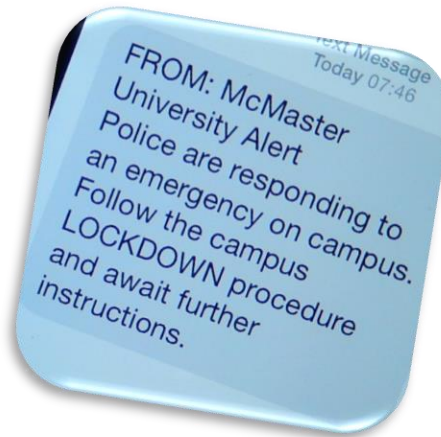
Be familiar with Lockdown Procedures

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EMERGENCY LOCKDOWN

- Exit the building if it is safe to do so

If you are unable to leave:

- Close, lock and barricade the door
- Cover the door windows
- Turn off the lights
- Lay on the floor, under furniture if possible
- DO NOT answer the door
- Wait for Police or security to assist you out of the building

CAMPUS VIOLENCE

If you encounter a violent act:
(Shooter or hostage situation)

- **RUN:** if safe to do so, move quickly away from the area; OR
- **HIDE:** if not safe to move, hide as best you can, locking or barricading the doors; OR
- **FIGHT:** as a last resort, try to disrupt or incapacitate the perpetrator
- If hiding, stay hidden until an all clear is given

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EMERGENCIES ON CAMPUS LOCKDOWN

Be familiar with Lockdown Notifications

Listen for Sirens

Register to receive text messages

Read Building LCD Screens

FROM: McMaster University Alert
Police are responding to an emergency on campus.
Follow the campus LOCKDOWN procedure and await further instructions.

Text Message
Today 07:46

Emergency Alert System

following buildings: Ar

EMERGENCIES ON CAMPUS

McMaster University
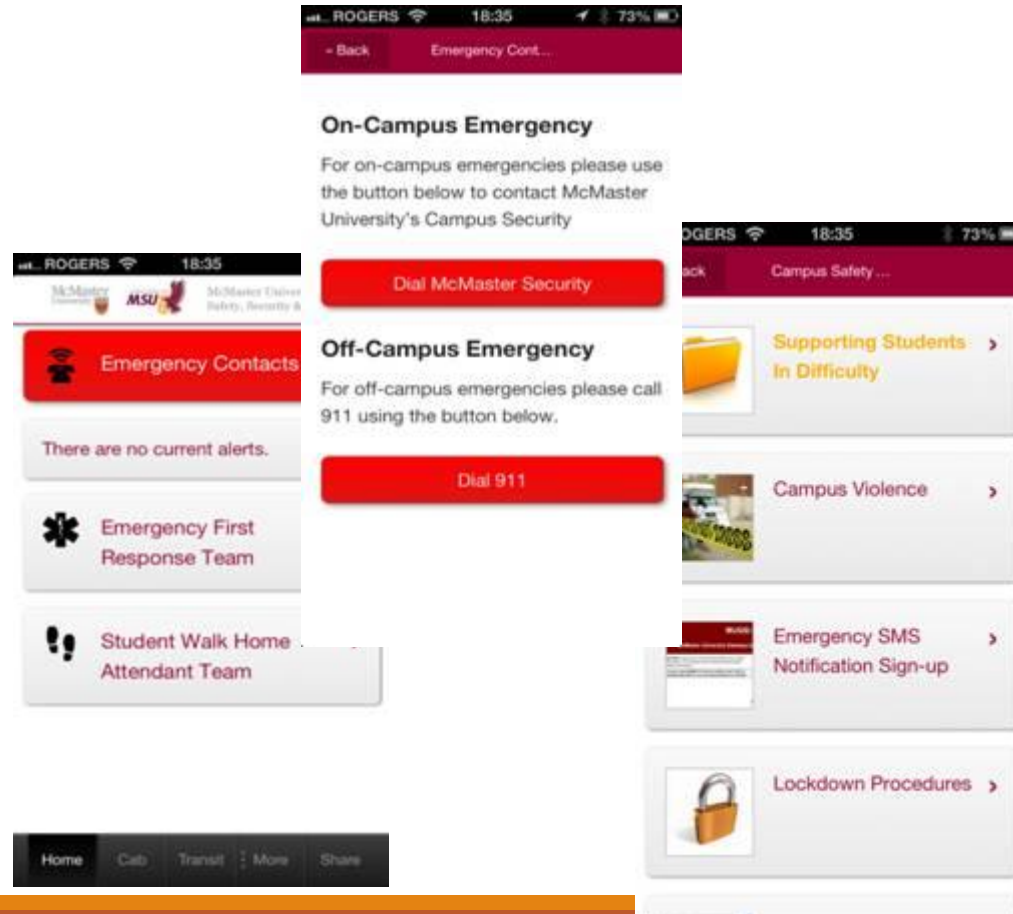
Download the MUSST Safety App

- Available in all app stores
- FREE
- Quick dialing for emergencies
- Quick emergency references

EMERGENCIES ON CAMPUS

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MEDICAL

If someone requires medical assistance:

- Request Emergency First Response Team (EFRT) or an ambulance
- Describe the medical emergency to the dispatcher
- Keep the individual calm and provide information to responders

For ALL Emergencies on Campus:
905-522-4135
Dial 88
from campus phones

or **The MUSST safety App**

FIRE

- Pull the nearest fire alarm and exit the building
- Leave the building immediately
- **DO NOT** use elevators
- Keep all accesses clear
- **DO NOT** re-enter the building
- Await instructions from McMaster Security Services

McMaster University SECURITY SERVICES