PLEASE MUTE YOUR MICROPHONES DURING THE PRESENTATION

WELCOME TO THE MEETINGS FOR MAJORS IN COMPUTER ENGINEERING / ENGINEERING SYSTEMS & COMPUTING

UNIVERSITY of GUELPH

IMPROVE LIFE.

WHAT IS ENGINEERING?

- Addresses societal need to solve problems - previously simple, now complex
- Employs a systematic approach
- Safety is a factor
- Solution is optimized

A LITTLE BIT OF HISTORY…

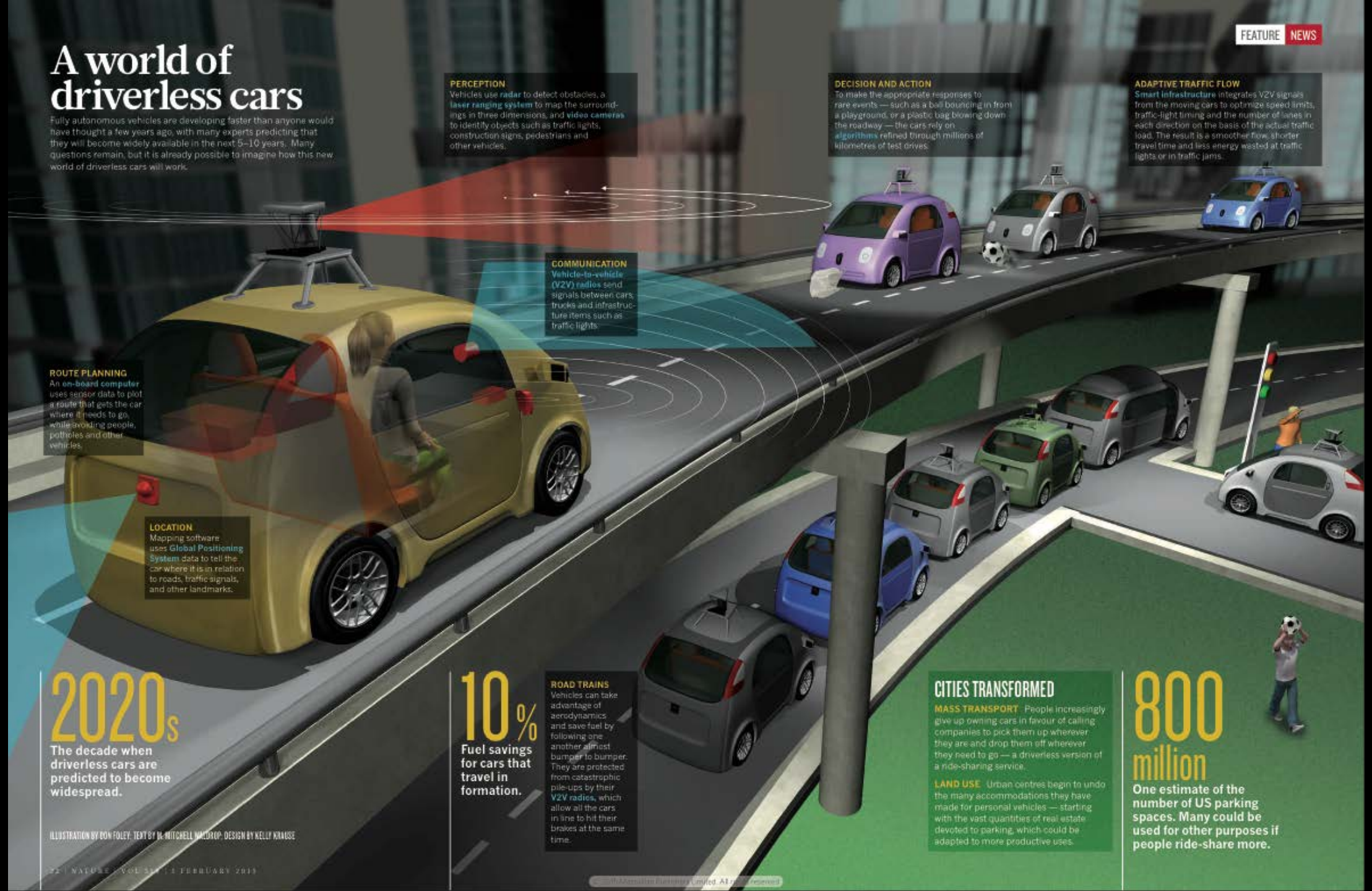
THE AUTOMOTIVE EVOLUTION

1900 - Mostly mechanical machines
1950 - Electro-mechanical machines
1970 - 4% electronics components
1980s - Autonomous vehicles introduced
2003 - 20% electronics components
2010 - 30% electronics components
2020 - 35% electronics components (forecast)
2030 - 35% electronics components (forecast)

Source: Statista 2019

A world of driverless cars

Fully autonomous vehicles are developing faster than anyone would have thought a few years ago, with many experts predicting that they will become widely available in the next 5–10 years. Many questions remain, but it is already possible to imagine how this new world of driverless cars will work.



PERCEPTION
Vehicles use **radar** to detect obstacles, a **laser ranging system** to map the surroundings in three dimensions, and **video cameras** to identify objects such as traffic lights, construction signs, pedestrians and other vehicles.

DECISION AND ACTION
To make the appropriate responses to rare events — such as a ball bouncing in front a playground, or a plastic bag blowing down the roadway — the cars rely on **algorithms** refined through millions of kilometres of test drives.

ADAPTIVE TRAFFIC FLOW
Smart infrastructure integrates V2V signals from the moving cars to optimize speed limits, traffic-light timing and the number of lanes in each direction on the basis of the actual traffic load. The result is a smoother flow, shorter travel time and less energy wasted at traffic lights or in traffic jams.

COMMUNICATION
Vehicle-to-vehicle (V2V) radios send signals between cars, trucks and infrastructure items such as traffic lights.

ROUTE PLANNING
An **on-board computer** uses sensor data to plot a route that gets the car where it needs to go, while avoiding people, potholes and other vehicles.

LOCATION
Mapping software uses **Global Positioning System** data to tell the car where it is in relation to roads, traffic signals, and other landmarks.

2020s

The decade when driverless cars are predicted to become widespread.

10%

Fuel savings for cars that travel in formation.

ROAD TRAINS
Vehicles can take advantage of aerodynamics and save fuel by following one another almost bumper to bumper. They are protected from catastrophic pile-ups by their **V2V radios**, which allow all the cars in line to hit their brakes at the same time.

CITIES TRANSFORMED

MASS TRANSPORT People increasingly give up owning cars in favour of calling companies to pick them up wherever they are and drop them off wherever they need to go — a driverless version of a ride-sharing service.

LAND USE Urban centres begin to undo the many accommodations they have made for personal vehicles — starting with the vast quantities of real estate devoted to parking, which could be adapted to more productive uses.

800 million

One estimate of the number of US parking spaces. Many could be used for other purposes if people ride-share more.

ILLUSTRATION BY DON FOLEY. TEXT BY M. MITCHELL WALDROP. DESIGN BY KELLY KRAUSE

ENGINEERING SYSTEMS & COMPUTING

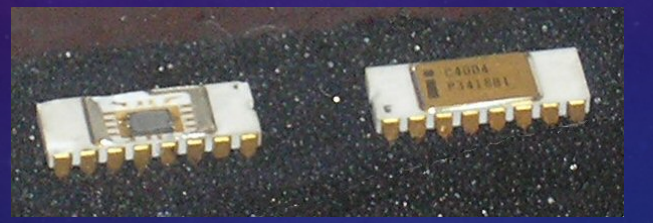
- Only program in Canada that focuses on developing computer-based engineering systems
- A unique mix of software development, hardware design, signal processing, control and modelling within a systems thinking perspective.

COMPUTER ENGINEERING –BUILDING COMPUTING MACHINES

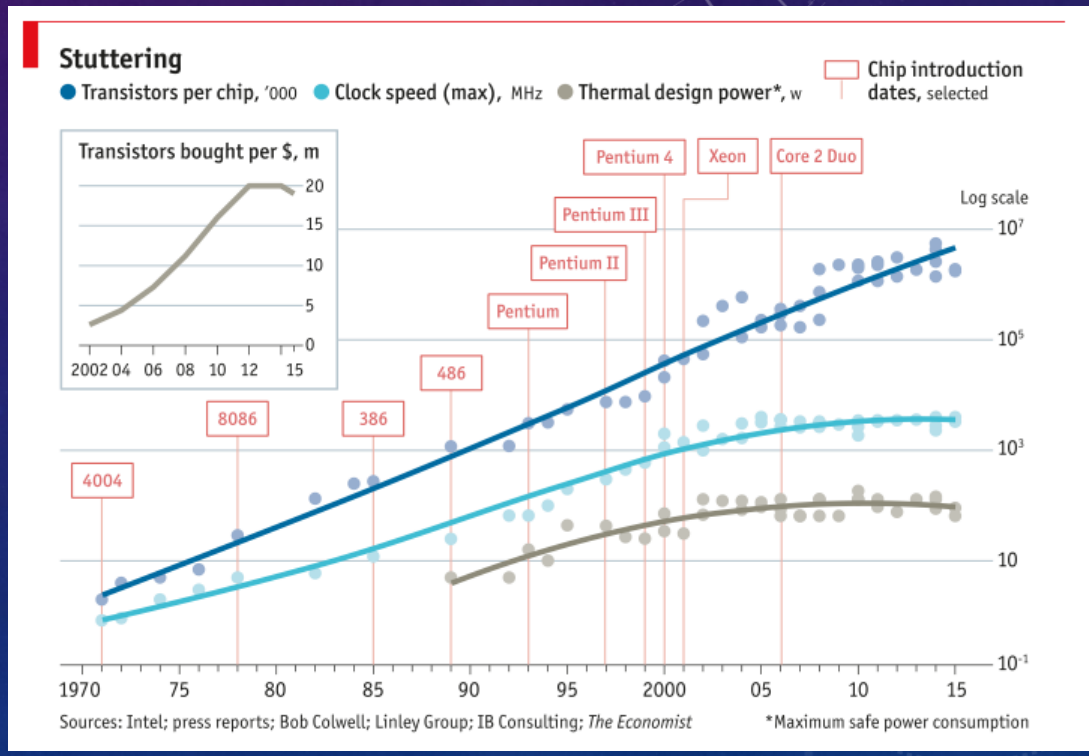
1945 ENIAC Electronic Numerical Integrator And Computer

Glen Beck (background) and Betty Snyder (foreground) program ENIAC in BRL building 328. (U.S. Army photo)

C4004- 1971



Wikipedia, the free encyclopedia



via The Economist

COMPUTER ENGINEERING- BEYOND MICROPROCESSORS

- Internet
- Cloud computing
- Smart sensors
- Smart phones
- Tablets
- Wearables
- Internet of Things

https://developer.getpebble.com/

https://nest.com/

COMPUTER SCIENCE VS. ENGINEERING

Computer Scientist

- Concerned with **computational theory**
- Develops techniques and tools
- Proves theorems about algorithms, designs languages, defines knowledge representation schemes

Engineer

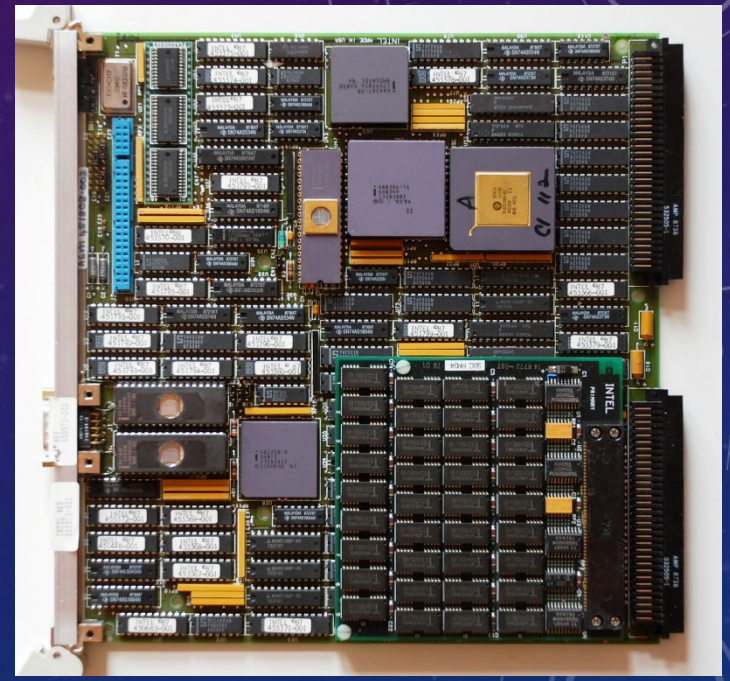
- Takes the theory and applies it to real life
- Develops a solution for a problem formulated by a client
- Uses computer & languages, techniques and tools

WHY CHOOSE GUELPH?

- Flexibility
  - "I changed my mind… I'd rather be in Biological, but I'm already in second year!"
    - With a common core, it's easy to switch disciplines
  - Co-op options
  - Design courses
- Multidisciplinary faculty and student groups
  - Environmental engineering students working with computer engineering students
- Common core:
  - Unfortunately, this sometimes means large classes - but:
  - Lots of small specialty classes: 36% have < 40 students (22% with < 20 students)

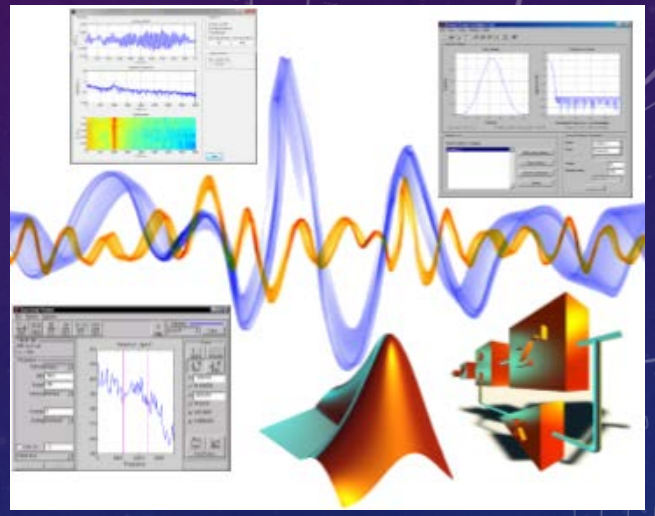
FOR EXAMPLE….

- ENGG*3380 – Computer Organization and Design
  - This course contains a detailed examination of modern computer organization and techniques for microprocessor architecture design.
    - Design focus
    - Hands-on labs
    - Small classes



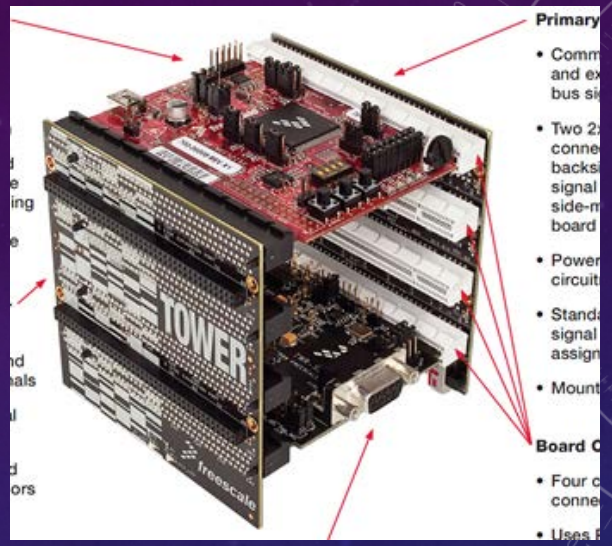
FOR EXAMPLE….

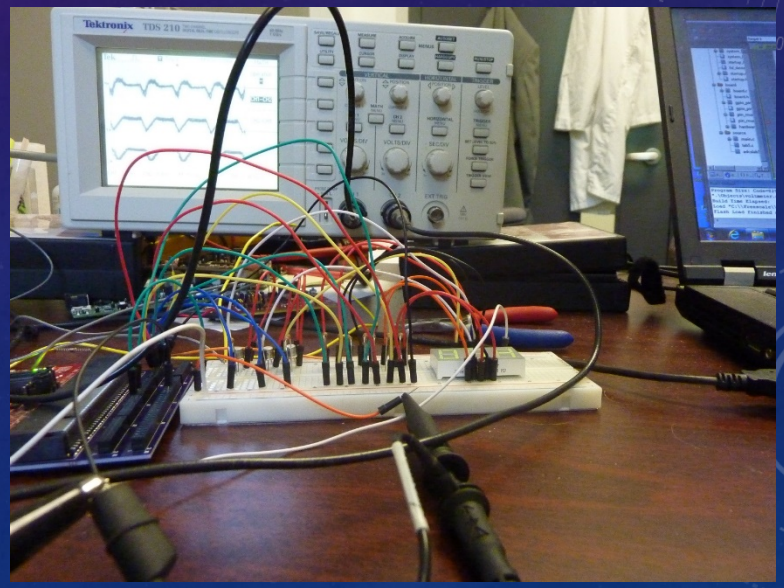
- ENGG*3390 – Signal Processing
- This course will establish the fundamental analysis and design techniques for signal processing systems.
    - Hands-on labs
    - Medium size classes
    - Fundamentals and practical skills at the end of third year



FOR EXAMPLE….

- ENGG*3640 – Microcomputer Interfacing
- This course focuses on the subject of interfacing microcomputers to external equipment.
    - Design focus
    - Hands-on labs using commercial microcontrollers
    - Small class





FOR EXAMPLE….

- ENGG*4490 – Sampled Data Control Design
- This course covers design, analysis synthesis and simulation of process control and automation systems.
    - 4th year, advanced labs
    - Self-guided, open-ended design lab
    - Highly interactive

FOR EXAMPLE….

- ENGG*3130 – Modelling Complex Systems
- This course explores the application of systems thinking to complex networks, agent-based models, artificial intelligence & machine learning.
    - Python-based labs
    - Small classes
    - Game-playing activities to reinforce systems thinking
    - Application to real life systems

ENGINEERING @ GUELPH

Multi-disciplinary, flexible, personal

PROGRAM DETAILS

Semester 1

- CHEM*1040: General Chemistry I
- CIS*1300: Programming
- ENGG*1100: Engineering and Design I
- MATH*1200: Calculus I
- PHYS*1130 Physics with Applications

Semester 2

- CIS*2500: Intermediate Programming
- ENGG*1210: Engineering Mechanics I
- ENGG*1500: Engineering Analysis I
- MATH*1210: Calculus II
- PHYS*1010: Intr. Electricity and Magnetism

SECOND YEAR

Semester 3 (Computer)

- CIS*2430: Object Oriented Programming
- CIS*2520: Data Structures
- ENGG*2400: Engineering Systems Analysis
- ENGG*2410: Digital Systems Design using Descriptive Languages
- MATH*2270: Applied Differential Equations
- **STAT*2120: Probability & Statistics for Engineers**

Semester 3 (ES&C)

- CIS*2430: Object Oriented Programming
- CIS*2520: Data Structures
- **ENGG*2230 Fluid Mechanics**
- ENGG*2400: Engineering Systems Analysis
- ENGG*2410: Digital Systems Design using Descriptive Languages
- MATH*2270: Applied Differential Equations

SECOND YEAR

Semester 4 (Computer)

- CIS*2910: Discrete Structures in Computing II
- ENGG 2100: Engineering and Design II
- ENGG 2450: Electric Circuits
- **ENGG*3380: Computer Organization and Design**
- MATH*2130: Numerical Methods
- 1 Elective (CIS 2750 for the software area of interest)

Semester 4 (ES&C)

- ENGG 2100: Engineering and Design II
- **ENGG*2120: Material Science**
- ENGG 2450: Electric Circuits
- MATH*2130: Numerical Methods
- STAT 2120: Probability and Statistics for Engineers
- 1 Elective (CIS 2750 for the computing area of interest)

THIRD YEAR

Semester 5 (Computer)

- ENGG*2120: Material Science
- ENGG*3390: Signal Processing
- ENGG*3450: Electronic Devices
- ENGG*3640: Microcomputer Interfacing
- HIST*1250: Science & Technology in a Global Context
- 1 Elective

Semester 5 (ES&C)

- **ENGG 3260: Thermodynamics**
- ENGG 3390: Signal Processing
- ENGG*3450: Electronic Devices
- ENGG*3640: Microcomputer Interfacing
- 2 Electives

THIRD YEAR

Semester 6 (Computer)

- **CIS*3110: Operating Systems I**
- **CIS*3490: The Analysis & Design of Comp Algorithms**
- ENGG 3100: Engineering and Design III
- **ENGG*3210: Communication Systems**
- ENGG*3410: Systems and Control Theory
- 1 Elective

Semester 6 (ES&C)

- ENGG 3100: Engineering and Design III
- **ENGG*3130: Modelling Complex Systems**
- ENGG*3410: Systems and Control Theory
- **ENGG 3430: Heat and Mass Transfer**
- HIST*1250: Science & Technology in a Global Context
- 1 Elective

FOURTH YEAR

Semester 7 (Computer)

- ENGG*3050 Embedded Reconfigurable Computing Systems
- ENGG*3240: Engineering Economics
- ENGG*4000: Proposal for Engineering Design IV
- ENGG*4420: Real-time Systems Design
- ENGG*4550: Large-scale Software Architecture Engineering
- 2 Electives

Semester 7 (ES&C)

- ENGG*3240: Engineering Economics
- ENGG*4000: Proposal for Engineering Design IV
- ENGG*4420: Real-time Systems Design
- ENGG*4550: Large-scale Software Architecture Engineering
- 2 Electives (1.0 or 1.25 credits)

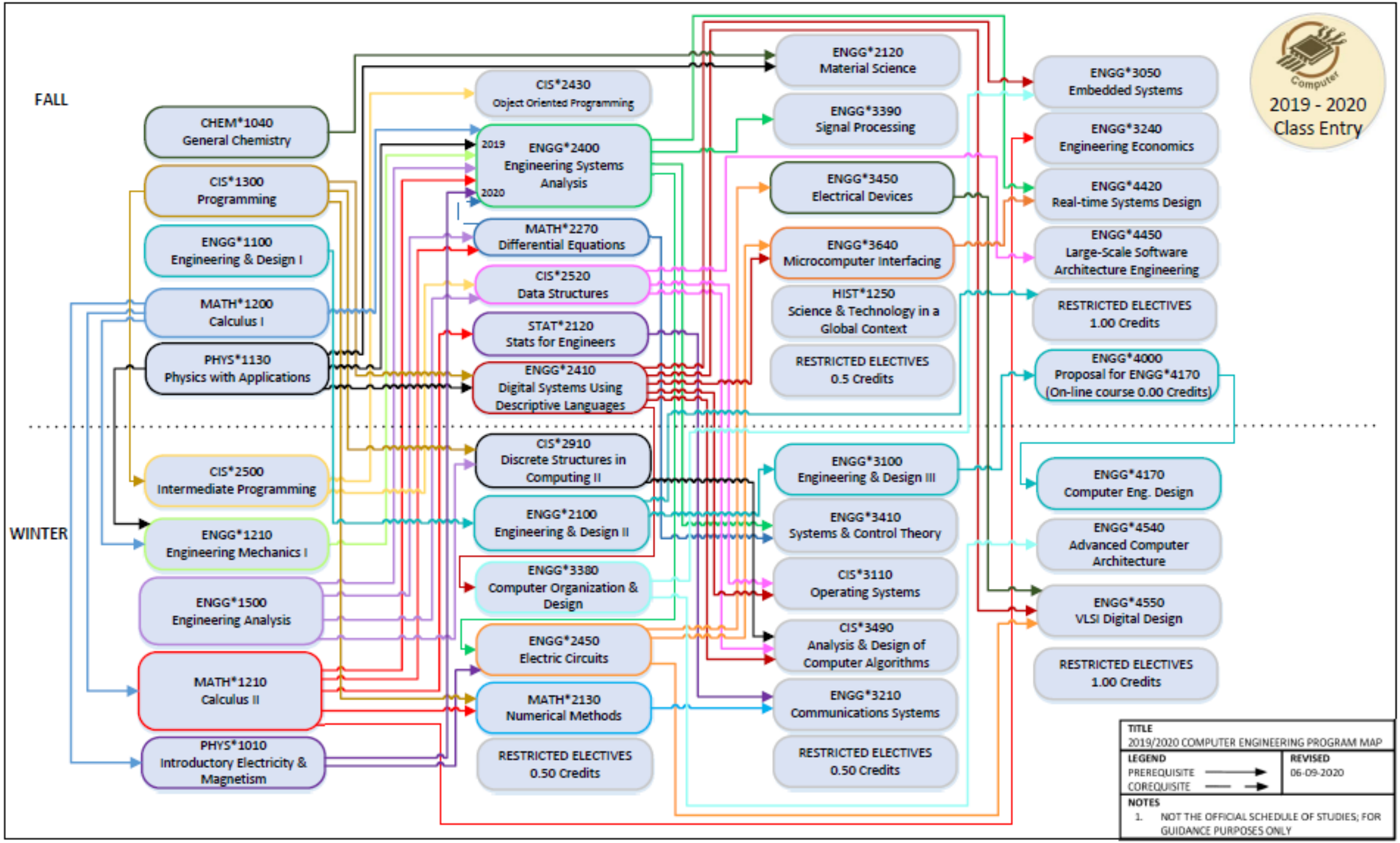
FOURTH YEAR

Semester 8 (Computer)

- **ENGG*4170: Computer Engineering Design IV**
- **ENGG*4540: Advanced Computer Architecture**
- **ENGG*4550 VLSI digital design**
- 2 Electives

Semester 8 (ES&C)

- **ENGG*4120: Engineering Systems and Computing Design IV**
- **ENGG 4490: Sampled Data Control Design**
- 2 Electives (1.0 or 1.25 credits)


FALL
WINTER
CHEM*1040 General Chemistry
CIS*1300 Programming
ENGG*1100 Engineering & Design I
MATH*1200 Calculus I
PHYS*1130 Physics with Applications
CIS*2500 Intermediate Programming
ENGG*1210 Engineering Mechanics I
ENGG*1500 Engineering Analysis
MATH*1210 Calculus II
PHYS*1010 Introductory Electricity & Magnetism
CIS*2430 Object Oriented Programming
2019
ENGG*2400 Engineering Systems Analysis
2020
MATH*2270 Differential Equations
CIS*2520 Data Structures
STAT*2120 Stats for Engineers
ENGG*2410 Digital Systems Using Descriptive Languages
CIS*2910 Discrete Structures in Computing II
ENGG*2100 Engineering & Design II
ENGG*3380 Computer Organization & Design
ENGG*2450 Electric Circuits
MATH*2130 Numerical Methods
RESTRICTED ELECTIVES 0.50 Credits
ENGG*2120 Material Science
ENGG*3390 Signal Processing
ENGG*3450 Electrical Devices
ENGG*3640 Microcomputer Interfacing
HIST*1250 Science & Technology in a Global Context
RESTRICTED ELECTIVES 0.5 Credits
ENGG*3100 Engineering & Design III
ENGG*3410 Systems & Control Theory
CIS*3110 Operating Systems
CIS*3490 Analysis & Design of Computer Algorithms
ENGG*3210 Communications Systems
RESTRICTED ELECTIVES 0.50 Credits
ENGG*3050 Embedded Systems
ENGG*3240 Engineering Economics
ENGG*4420 Real-time Systems Design
ENGG*4450 Large-Scale Software Architecture Engineering
RESTRICTED ELECTIVES 1.00 Credits
ENGG*4000 Proposal for ENGG*4170 (On-line course 0.00 Credits)
ENGG*4170 Computer Eng. Design
ENGG*4540 Advanced Computer Architecture
ENGG*4550 VLSI Digital Design
RESTRICTED ELECTIVES 1.00 Credits
Computer
2019 - 2020 Class Entry
TITLE
2019/2020 COMPUTER ENGINEERING PROGRAM MAP
LEGEND
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COREQUISITE
REVISED
06-09-2020
NOTES
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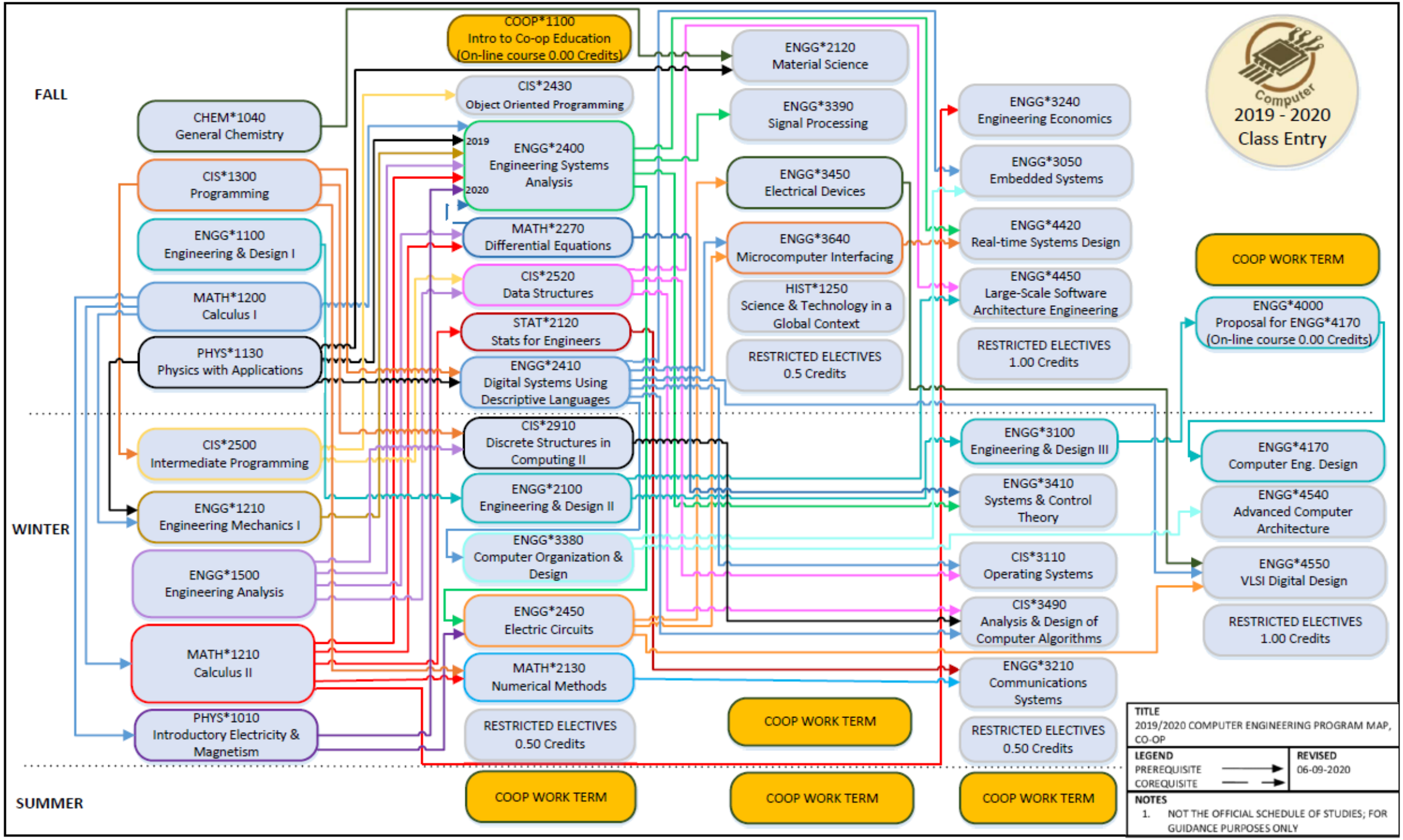
FALL
WINTER
SUMMER
COOP*1100
Intro to Co-op Education
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CHEM*1040
General Chemistry
CIS*1300
Programming
ENGG*1100
Engineering & Design I
MATH*1200
Calculus I
PHYS*1130
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ENGG*3050
Embedded Systems
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Real-time Systems Design
ENGG*4450
Large-Scale Software Architecture Engineering
RESTRICTED ELECTIVES
1.00 Credits
ENGG*3100
Engineering & Design III
ENGG*3410
Systems & Control Theory
CIS*3110
Operating Systems
CIS*3490
Analysis & Design of Computer Algorithms
ENGG*3210
Communications Systems
RESTRICTED ELECTIVES
0.50 Credits
COOP WORK TERM
COOP WORK TERM
ENGG*4000
Proposal for ENGG*4170
(On-line course 0.00 Credits)
ENGG*4170
Computer Eng. Design
ENGG*4540
Advanced Computer Architecture
ENGG*4550
VLSI Digital Design
RESTRICTED ELECTIVES
1.00 Credits
Computer
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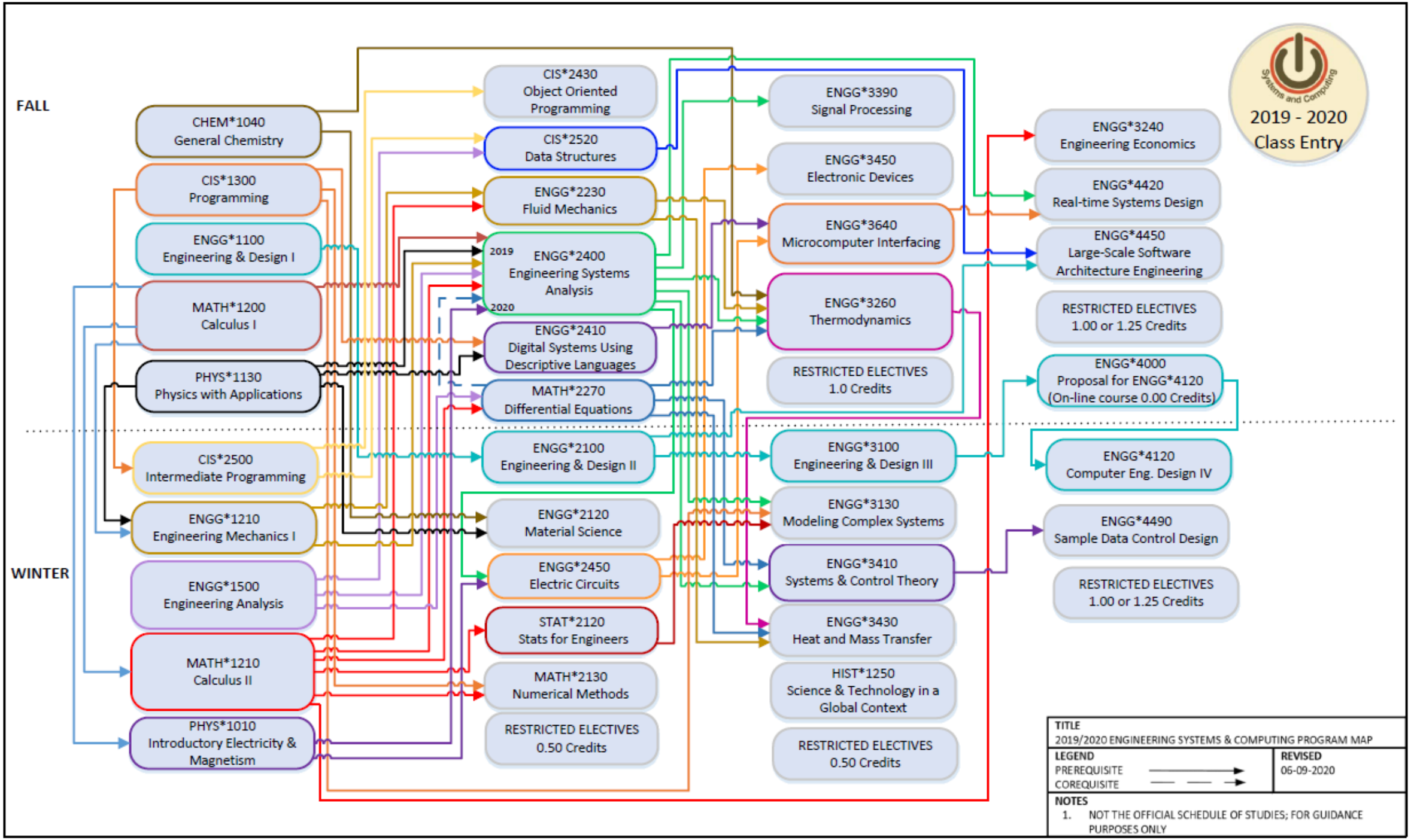
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Systems & Control Theory
ENGG*3430
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Large-Scale Software Architecture Engineering
RESTRICTED ELECTIVES
1.00 or 1.25 Credits
ENGG*4000
Proposal for ENGG*4120
(On-line course 0.00 Credits)
ENGG*4120
Computer Eng. Design IV
ENGG*4490
Sample Data Control Design
RESTRICTED ELECTIVES
1.00 or 1.25 Credits
Systems and Computing
2019 - 2020
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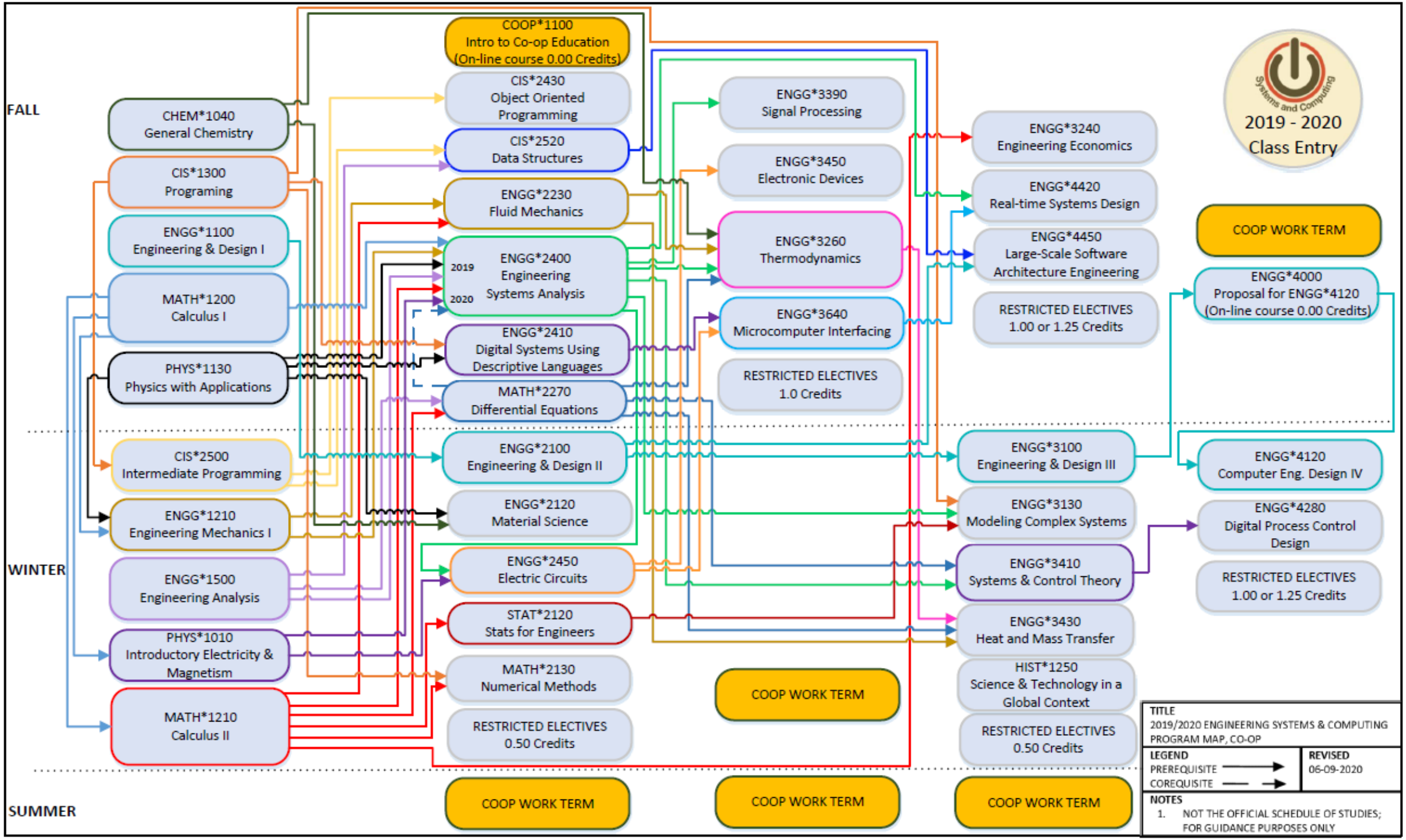
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Real-time Systems Design
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(On-line course 0.00 Credits)
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Design
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WHAT CAN I SPECIALIZE IN AT U OF GUELPH ES&C/CE?

STREAMS

- **Streams are optional** and students are free to mix and match between streams or pick any elective courses from ESC-1, ESC-2, CENG-1.

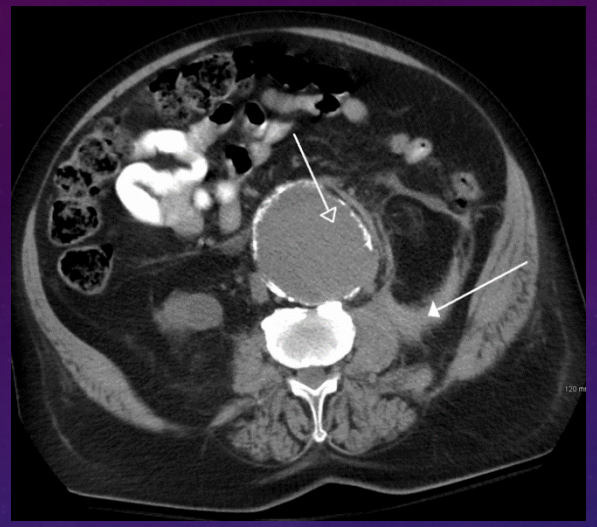
- Students who wish to strengthen their knowledge in a **particular specialization** are encouraged to take all 2.00 credits from one stream.

ES&C

Embedded Systems

Terasic DE10-nano board

Biomedical



Computing

criticalcase.com

Mechatronics

spectrum.ieee.org

CE

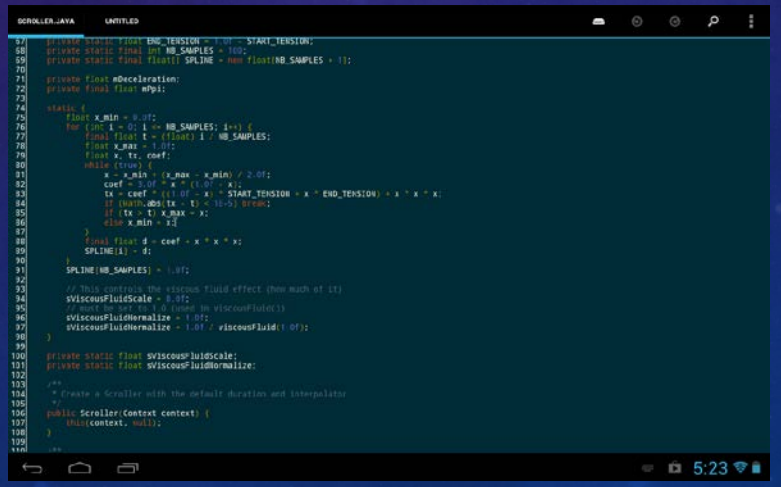
Electronic Design Automation

www.t3.com

Microsystems

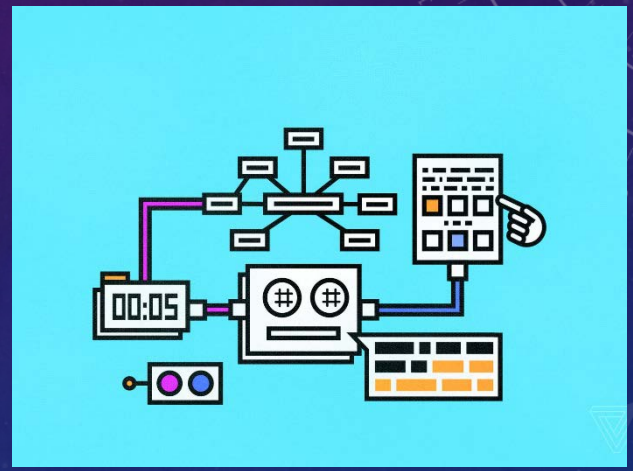
limemicro.com

Software



play.google.com

Robotics & AI



theverge.com

TEAM

Lei Lei

PhD, Beijing Univ, 2006

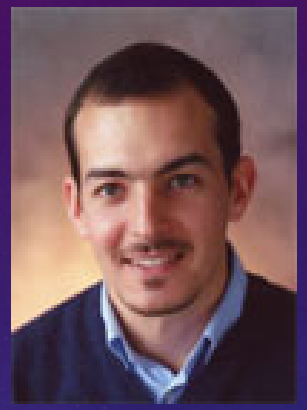
Shawki Areibi

PhD, U of Waterloo, 1995, P.Eng

Petros Spachos

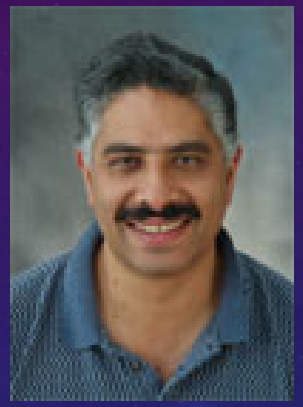
PhD, U of Toronto, 2014

Stefano Gregori



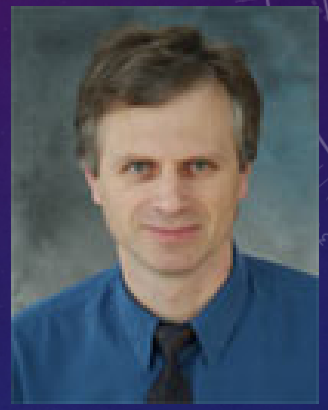
PhD, U of Pavia, 2002, P.Eng

Medhat Moussa



PhD, U of Waterloo 1996, P.Eng

Radu Muresan



PhD, U of Waterloo, 2003, P.Eng.

Kevin Dong

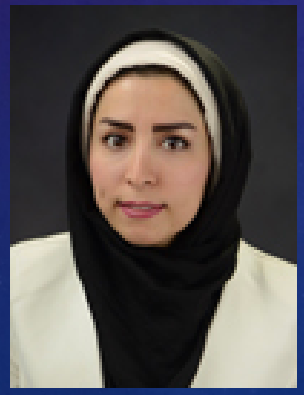
Graham Taylor

Ph.D. U of Toronto 2009, P.Eng

Julie Vale

Ph.D., U of Waterloo 2010, P.Eng

Hadis Karimipour



Ph.D., U of Alberta 2016, P.Eng

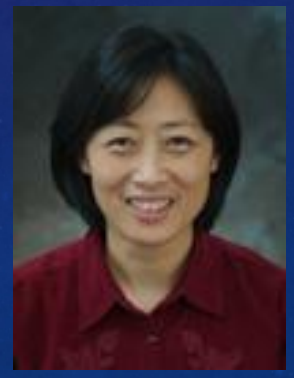
Simon Yang

PhD, Alberta 1999, P.Eng

Mohamad Abou El Nasr

Ph.D., U of Waterloo 2017, EIT

Hong Ma



Matthew Saunders

LEI LEI

PhD, U of Glasgow, 1992, P.Eng

Courses

ENGG*4430 (Neural-Fuzzy and Soft Computing Systems)

Research Interests

- Deep Reinforcement Learning
- Internet of Things
- Mobile Edge Computing
- Smart Grid

SHAWKI AREIBI

PhD, U of Waterloo,
1995, P.Eng

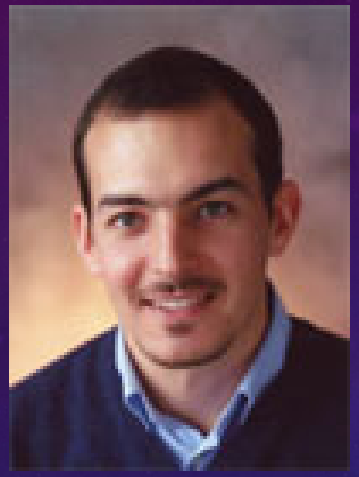
Courses

- ENGG*2410 (Digital Design)
- ENGG*3050 (Reconfigurable Computing)
- ENGG*6530 (Reconfigurable Systems)

Research Interests

- VLSI Physical Design Automation
- Computer Architecture
- Reconfigurable Computing Systems
- Embedded Systems
- Machine Learning

STEFANO GREGORI



Doctorate
University of Pavia, 2002

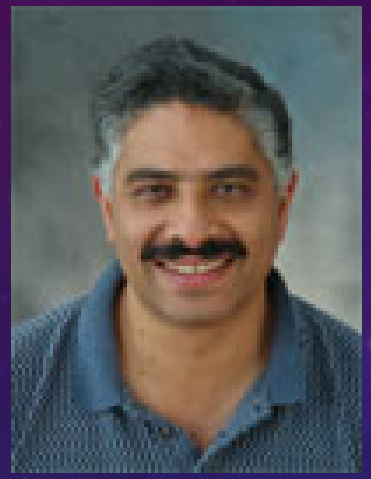
Courses

- ENGG*3450 (Electronic Devices)
- ENGG*4080 (Micro/Nano Scale Elect)
- ENGG*6510 (Analog IC Design)

Research Interests

- Low-voltage low-power mixed-signal ICs
- Low-power integrated sensors
- Ultra-dense Flash memories
- Data converters
- Micro-sensors and Analog Interfaces

MEDHAT MOUSSA



PhD, U of Waterloo
1996, P.Eng

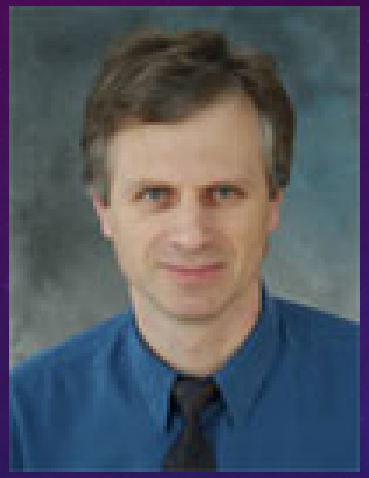
Courses

- ENGG*3380 (Embedded Arch Design)
- ENGG*4460 (Robotic Systems)

Research Interests

- User-adaptive Intelligent Systems
- Reconfigurable Computing Systems
- Machine vision

RADU MURESAN



PhD, U of Waterloo, 2003, P.Eng.

Courses

- ENGG*4420 (Real Time Systems) (F)
- ENGG*4550 (VLSI Digital Systems) (W)
- ENGG*4560 (Embedded Systems) (W)
- ENGG*3640 (Microcomputer Interfacing) (F)

Research Interests

- Low power VLSI design
- Security: cryptographic hardware and cipher design
- Real-time embedded design
- Intelligent transportation systems

PETROS SPACHOS

PhD, Toronto, 2014

Courses

- ENGG*4200 (Wireless Sensor Networks)
- ENGG*3210 (Communication Systems)
- ENGG*6400 (Mobile Device Applications)

Research Interests

- Wireless Sensor Networks
- Network Protocols
- Network Programming
- Smart Cities and IoT

GRAHAM TAYLOR

PhD, U of Toronto, 2009

Courses

- ENGG 3130 (Modeling Complex Systems)
- ENGG*6500 (Machine Learning)
- UNIV*6080 (Computational Thinking for AI)

Research Interests

Machine Learning:

- Deep Learning and Representation Learning
- Learning from sequences (time series)
- Applications to computer vision
- Large-scale ML and hardware acceleration

JULIE VALE

PhD, U of Waterloo, 2010

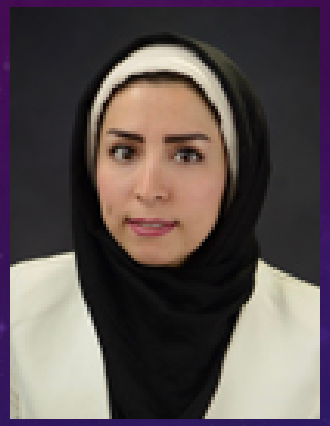
Courses

- ENGG*2450 (Electrical Circuits)
- ENGG*4280 (Digital Process Control)
- ENGG*3410 (Systems and Control)
- ENGG*6060 (Systems Modelling)
- ENGG*6580 (Advanced Control)

Research Interests

- Engineering Education
- Control Theory

HADIS KARIMIPOUR



PhD, U of Alberta, 2015

Courses

- ENGG*3390 (Signal Processing)
- ENGG*3410 (Systems and Control)
- ENGG*6140 (Optimization Techniques)

Research Interests

- Control System Modeling and Analysis
- Machine Learning/Deep Learning
- Power Systems Monitoring and Analysis
- Smart Grid Modeling, Analysis and Security

SIMON YANG

PhD, U of Alberta, 1999

Courses

- ENGG*3410 (Systems and Control Theory)
- ENGG*4430 (Neuro-Fuzzy/Soft Computing)
- ENGG*6570 (Advanced Soft Computing)
- ENGG*6580 (Advanced Control Systems)

Research Interests

- Biological and Artificial Intelligent Systems
- Robotics and Automation
- Intelligent Control Systems

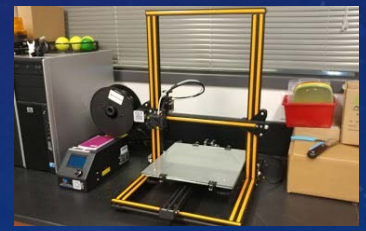
DESIGN COMPETITIONS

- ACM International Programming Contest
- Computer Society Int. Design Competition
- RoboCup
- RescueRobot
- Formula SAE Racing
- Robotics Team
- Autonomous Sailing
- Ont Eng. Competition: Programming Track

ROBOTICS TEAM

- At the beginning of each year, hosts an introductory sumo bot competition
- Team regularly competes in the Canadian International Rover Challenge (CIRC)
- Students also built an underwater robot

http://ugrt.ca



OEC: PROGRAMMING TRACK

- The 2014 Ontario Engineering Competition added a Programming category for the first time
- The SOE Team placed 2nd out of 5 teams – they were 2nd year students mainly competing against seniors
- They designed a HTML5-based mapping mobile app
- $1,000 prize and new phones!

Clockwise from bottom left are Mark Nijjar, Paul Szaloky, Anthony Burkholder and Farhad Rahbarnia.

ENGINEERING @ GUELPH

Multi-disciplenary, flexible, personal

Faculty and Staff wish you a wonderful journey in SOE!