ECE HANDBOOK

2020-21

University of Manitoba
Engineering Society

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Table of Contents

Electrical and Computer Engineering

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Department Descriptions

The work of Computer Engineers is sometimes hidden and embedded into everyday objects such as cars, bank machines and smartphones. Computer Engineering students receive a broad education which encompasses both the hardware and software aspects of any application. In addition to the standard Computer Engineering program, the department offers three focus areas for interested students. These include the study of Embedded Systems, Communication Networks and Machine Vision.

Electrical and electronic systems are present in every aspect of life, from the power that lights a house at night to the toaster that prepares breakfast in the morning. Life would be very different without the benefits of these and other devices designed chiefly by electrical engineers. In addition to the traditional fields of electric power systems and telecommunications, today's electrical engineers are also expanding their work into fields such as biomedical devices and micro-electronics. In addition to the standard Electrical Engineering program, the department offers four focus areas for interested students. These include the study of Power and Energy Systems, Wireless Communication Devices, Biomedical Engineering and Engineering Physics. Students interested any of these programs should consult with the Electrical and Computer Department Office to select an appropriate set of elective courses.

What are the Focus Areas?

Students wishing to pursue more focused studies in an Electrical Engineering subject/research area can do so by choosing one of the approved focus areas. The Electrical Engineering program offers four focus areas; Power and Energy Systems, Communication Devices, Biomedical and Engineering Physics. More information about the focus areas can be found here.

The Electrical Engineering Program requires students to take 7 Technical Electives and 1 Natural Science Elective. The technical elective structure has recently changed, effective September 2016. Students who were enrolled in the Electrical Engineering degree program prior to this change may choose to follow the new structure or may complete their degree using the previous technical elective structure. Information on both technical elective structures and a full list of available courses can be found on the Technical and Science Electives page.

Students wishing to pursue more focused studies a Computer Engineering subject/research area can do so by choosing one of the approved focus areas. The Computer Engineering program offers three focus areas; Computer Networks and Communications, Embedded Systems, and Software Engineering. More information about the focus areas can be found here.

The Computer Engineering Program requires students to take 2 Natural Science Electives and 5 Technical Electives, with a maximum of 2 Electrical Engineering technical electives. The full list of available courses can be found on the Technical and Science Electives page.

Tips for Incoming ECE Students

These tips are from current electrical and computer students.

1. If they are available, old midterms and finals are one of the best ways to prepare for your exams. Pay attention to the style of questions your professor has given in the past and to the concepts that were emphasized in previous years' exams.

2. Make friends, you will have several group projects for which you get to choose your partners.
3. Don't leave all of your tech electives for your last year, they conflict with each other and you will not be able to get into the courses you want.
4. Consider taking your complimentary electives in the evenings during the summer. They are less demanding, and you can lighten your course load during the school year.
5. In your circuits labs you will be taught how to use an oscilloscope and function generator. Make sure you fully understand how to use them, as they will be necessary for many subsequent courses.
6. You can buy a student version of multisim (a circuit simulator) for $60. This is a great investment, as it will help you complete design projects, labs and assignments more efficiently.
7. You can buy a student version of matlab for $100. Matlab will be used in labs for several different courses, so it is important to become proficient at matlab programming. There are lots of free tutorials available online.
8. Design projects are an important part of many of the courses in electrical engineering. Get started as early as possible on all design projects and keep in mind that the physical circuit will not behave exactly like the simulation. The Engineers in Residence are a great source of information about design, so make sure to ask lots of questions about the design process and your projects.
9. The concepts covered in Math 1-3 are extremely important for a lot of your electrical courses, so make sure you understand these topics very well.
10. Always use a multimeter to check the values of your resistors and capacitors. The components often get mixed up and this will save you a lot of time in the lab. You can also memorize the resistor colour codes.
11. If you need to pick up components for your projects or labs, visit the tech shop (E3-541). There are resistors, capacitors and wires available for students in drawers at the front of the tech shop. You need to ask one of the technicians for op amps, inductors and transistors.
12. Many of your courses will have weekly quizzes or assignments. Even though they aren't worth a large percentage of your grade, put in as much effort as you can. Your marks in

13. Always complete the prelabs before your lab section. This will help to ensure you are able to finish the lab on time. The prelabs and lab reports are also a good chance to practice applying some of the topics you are covering in class.
14. Buy a pair of wire strippers. They are available at the book store and will be very useful in the labs and for your design projects.

Course List: Electrical Engineering

For the program checklist, visit:
http://umanitoba.ca/faculties/engineering/departments/ece/pdf/Electrical_Engineering_Program.pdf

For the 2020-2021 course timetable, visit:
http://www.umanitoba.ca/faculties/engineering/departments/ece/pdf/2020-2021_Course_Timetable.pdf

Second Year Courses		
Engineering Communication	(ENG 2030 **or** ENG 2040)	3CR
Engineering Mathematical Analysis 1	(MATH 2130)	3CR
Engineering Mathematical Analysis 2	(MATH 2132)	3CR
Electric Circuits	(ECE 2262)	4CR
Digital Logic Systems	(ECE 2220)	5CR
Ecology, Technology and Society	(ANTH 2430)	3CR
Modern Physics for Engineers	(PHYS 2152)	3CR
Numerical Methods for Electrical Engineers	(ECE 2240)	4CR
Electronics 2E	(ECE 2160)	5CR
Microprocessing Systems	(ECE 3610)	4CR

Third Year Courses		
Foundations of Electromagnetics	(ECE 3580)	4CR
Contemporary Statistics for Engineers	(STAT 2220)	3CR
Signal Processing 1	(ECE 3780)	4CR
Electric Power and Machines	(ECE 3720)	4CR
Electronics 3E	(ECE 3670)	4CR
Electromagnetic Theory	(ECE 3590)	4CR
Physical Electronics	(ECE 3600)	4CR
Communications Systems	(ECE 4260)	4CR
Advanced Circuit Analysis and Design	(ECE 3540)	4CR

Principles of Embedded System Design	(ECE 3730)	4CR

Fourth Year Courses		
Control Systems	(ECE 4150)	4CR
Group Design Project	(ECE 4600)	6CR
Engineering Economics	(CIVL 4050)	3CR

Technical Elective Courses

NOTE: Courses in italics are either new topics course offerings, or indicate a change in course number

GROUP A

FALL TERM 2020

Microwave Engineering	(ECE 4290)	4CR
Power Electronics	(ECE 4370)	4CR

WINTER TERM 2021

Control Engineering	(ECE 4160)	4CR
Digital Communications	(ECE 4250)	4CR
Signal Processing 2	(ECE 4830)	4CR

GROUP B

FALL TERM 2020

Microprocessor Interfacing	(ECE 4240)	4CR
Antennas	(ECE 4270)	4CR
Electrical Energy Systems 1	(ECE 4300)	4CR
Engineering Computation 4E	(ECE 4390)	4CR
Design of RF Devices and Wireless Systems	*(ECE 4430)*	*4CR*
Applied Computational Intelligence	*(ECE 4450)*	*4CR*
Parallel Processing	(ECE 4530)	4CR

Modern Computing Systems	*(ECE 4560)*	*4CR*
Wireless Networks	(ECE 4540)	4CR
Optoelectronics	(ECE 4580)	4CR
Biomedical Instrumentation and Signal Processing	(ECE 4610)	4CR
Digital System Implementation	(ECE 4740)	4CR
(T05) Applied Probability and Stochastic Processes	*(ECE 4860)*	*4CR*
Computer Science 2	(COMP 1020)	3CR
Data Structures and Algorithms	(COMP 2140)	3CR
Introduction to Artificial Intelligence	(COMP 3190)	3CR
Applied Discrete Mathematics	(MATH 3120)	3CR
Optics	(PHYS 2260)	3CR
Electro and Magnetodynamics and Special Relativity	(PHYS 4646)	3CR

WINTER TERM 2021

Electric Machines	(ECE 3650)	5CR
Telecommunication Networks Engineering	(ECE 3700)	4CR
Introduction to Microelectronic Fabrication	(ECE 4100)	4CR
Introduction to Robotics	(ECE 4180)	4CR
Electrical Energy Systems 2	(ECE 4310)	4CR
High Voltage Engineering	(ECE 4360)	4CR
Computer Vision	(ECE 4440)	4CR
(T02) Biomedical Signal Processing	(ECE 4860)	4CR
(T07) Materials Characterizations	(ECE 4860)	4CR
(T08) Sensors, Instrumentation, and the IoT	(ECE 4860)	4CR
(T09) Bioelectromagnetics	(ECE 4860)	4CR
(T12) Renewable Energy Systems	(ECE 4860)	4CR
(T14) Optimization Techniques	(ECE 4860)	4CR
Computer Science 2	(COMP 1020)	3CR
Data Structures and Algorithms	(COMP 2140)	3CR
Machine Learning	(COMP 4360)	3CR
Partial Differential Equations	(MATH 3460)	3CR

Medical Physics and Physiological Measurement	(PHYS 3220)	3CR
Advanced Optics	(PHYS 4590)	3CR

ELECTIVE COURSES NOT OFFERED IN 2020-2021

Please consult the ECE department website or your undergraduate advisor for more information about the following courses and when they are offered

Digital Systems Design 2	(ECE 3770)	4CR
Power Transmission Lines	(ECE 4140)	4CR
Electronic Filter Design	(ECE 4200)	4CR
Engineering Electromagnetics	(ECE 4280)	4CR
Digital Control	(ECE 4420)	4CR
Simulation and Modelling	(ECE 4520)	4CR
(T06) Random Signals and Processes	(ECE 4860)	4CR
(T05) Basics of Biological Signals Analysis	(ECE 4850)	4CR

Natural Science Electives

FALL 2020

Stars	(ASTR 3180)	3CR
Biology 1: Principles and Themes	(BIOL 1020)	3CR
Economic Plants	(BIOL 1300)	3CR
Anatomy of the Human Body	(BIOL 1410)	3CR
Introduction to Physical Chemistry	(CHEM 1310)	3CR
Introduction to Entomology	(ENTM 2050)	3CR
The Dynamic Earth	(GEOL 1340)	3CR
Essentials of Microbiology	(MBIO 1220)	3CR
Optics	(PHYS 2260)	3CR

WINTER 2021

Introduction to Astronomy: The Magnificent Universe	(ASTR 1810)	3CR
Introduction to Physical Chemistry	(CHEM 1310)	3CR

Introduction to Organic Chemistry	(CHEM 1320)	3CR
The Dynamic Earth	(GEOL 1340)	3CR
Essentials of Microbiology	(MBIO 1220)	3CR
Introduction to Quantum Mechanics and Special Relativity	(PHYS 2386)	3CR
Classical Mechanics 1	(PHYS 2650)	3CR
Medical Physics and Physiological Measurements	(PHYS 3220)	3CR

Course List: Computer Engineering

For the program checklist, visit:
http://umanitoba.ca/faculties/engineering/departments/ece/pdf/Computer_Engineering_Program.pdf

For the 2020-2021 course timetable, visit:
http://www.umanitoba.ca/faculties/engineering/departments/ece/pdf/2020-2021_Course_Timetable.pdf

Second Year Courses		
Engineering Communication	(ENG 2030 **or** ENG 2040)	3CR
Engineering Mathematical Analysis 1	(MATH 2130)	3CR
Engineering Mathematical Analysis 2	(MATH 2132)	3CR
Electric Circuits	(ECE 2262)	4CR
Digital Logic Systems	(ECE 2220)	5CR
Computer Science 2	(COMP 1020)	3CR
Modern Physics for Engineers	(PHYS 2152)	3CR
Engineering Mathematical Analysis 3	(MATH 3132)	3CR
Electronics 2E	(ECE 2160)	5CR
Microprocessing Systems	(ECE 3610)	4CR
Data Structures and Algorithms	(COMP 2140)	3CR
Engineering Algorithms	(ECE 3790)	4CR

Third Year Courses		
Contemporary Statistics for Engineers	(STAT 2220)	3CR
Applied Discrete Mathematics	(MATH 3120)	3CR
Signal Processing 1	(ECE 3780)	4CR
Microprocessor Interfacing	(ECE 4240)	4CR
Systems Engineering Principles 1	(ECE 3740)	4CR
Communication Systems	(ECE 4260)	4CR
Signal Processing 2	(ECE 4830)	4CR

Ecology, Technology and Society	(ANTH 2430)	3CR
Digital Systems Design 1	(ECE 3760)	4CR
Introduction to Operating Systems	(COMP 3430)	3CR
Telecommunication Network Engineering	(ECE 3700)	4CR

Fourth Year Courses		
Control Systems	(ECE 4150)	4CR
Group Design Project	(ECE 4600)	6CR
Engineering Economics	(CIVL 4050)	3CR

Technical Elective Courses		
FALL TERM 2020		
*Foundations of Electromagnetics	(ECE 3580)	4CR
*Electronics 3E	(ECE 3670)	4CR
*Electric Power and Machines	(ECE 3720)	4CR
*Control Systems	(ECE 4150)	4CR
*Communication Systems	(ECE 4260)	4CR
*Engineering Computation 4E	(ECE 4390)	4CR
Applied Computational Intelligence	*(ECE 4450)*	*4CR*
Parallel Processing	(ECE 4530)	4CR
Modern Computing Systems	*(ECE 4560)*	*4CR*
*Biomedical Instrumentation and Signal Processing	(ECE 4610)	4CR
Digital System Implementation	(ECE 4740)	4CR
(T05) Applied Probability and Stochastic Processes	*(ECE 4860)*	*4CR*
Programming Practices	(COMP 2160)	3CR
Human-Computer Interaction 1	(COMP 3020)	3CR
Introduction to Artificial Intelligence	(COMP 3190)	3CR
Database Concepts and Usage	(COMP 3380)	3CR
Computer Graphics 1	(COMP 3490)	3CR
Introduction to Data Mining	(COMP 4710)	3CR

WINTER 2021		
*Advanced Circuit Analysis and Design	(ECE 3540)	4CR
*Physical Electronics	(ECE 3600)	4CR
*Introduction to Microelectronic Fabrication	(ECE 4100)	4CR
*Control Systems	(ECE 4150)	4CR
Introduction to Robotics	(ECE 4180)	4CR
Digital Communications	(ECE 4250)	4CR
Computer Vision	(ECE 4440)	4CR
*Communication Systems	(ECE 4260)	4CR
(T02) Biomedical Signal Processing	(ECE 4860)	4CR
(T08) Sensors, Instrumentation, and the IoT	(ECE 4860)	4CR
(T14) Optimization Techniques	(ECE 4860)	4CR
Object Orientation	(COMP 2150)	3CR
Distributed Computing	(COMP 3010)	3CR
Software Engineering 1	(COMP 3350)	3CR
Human-Computer Interaction 2	(COMP 4020)	3CR
Artificial Intelligence	(COMP 4190)	3CR
Software Engineering 2	(COMP 4350)	3CR
Machine Learning	(COMP 4360)	3CR
Database Implementation	(COMP 4380)	3CR
Operating Systems 2	(COMP 4430)	3CR
Computer Graphics 2	(COMP 4490)	3CR
Computer Security	(COMP 4580)	3CR

ELECTIVE COURSES NOT OFFERED IN 2020-2021

Please consult the ECE department website or your undergraduate advisor for more information about the following courses and when they are offered

Systems Engineering Principles 2	(ECE 3750)	4CR
Digital Systems Design 2	(ECE 3770)	4CR
Power Transmission Lines	(ECE 4140)	4CR

Electronic Filter Design	(ECE 4200)	4CR
Engineering Electromagnetics	(ECE 4280)	4CR
Electric Energy Systems 2	(ECE 4310)	4CR
Digital Control	(ECE 4420)	4CR
Simulation and Modelling	(ECE 4520)	4CR
(T05) Basics of Biological Signals Analysis	(ECE 4850)	4CR
(T01) Random Signals and Processes	(ECE 4860)	4CR
Introduction to Compiler Construction	(COMP 3290)	3CR
Expert Systems	(COMP 4200)	3CR

Natural Science Electives

*Computer Engineering students are required to complete two (2) Natural Science Electives as part of their program. These courses may be taken anytime during the student's program.

One course must be selected from *Group A*. The second may be selected from either *Group A* or *Group B*.

GROUP A – FALL 2020

Introduction to Physical Chemistry	(CHEM 1310)	3CR
Electromagnetic Field Theory	(PHYS 2600)	3CR

GROUP A – WINTER 2021

Introduction to Physical Chemistry	(CHEM 1310)	3CR
Electro- and Magnetostatic Theory	(PHYS 3630)	3CR

GROUP B – FALL 2020

Stars	(ASTR 3180)	3CR
Biology 1: Principles and Themes	(BIOL 1020)	3CR
Economic Plants	(BIOL 1300)	3CR
Anatomy of the Human Body	(BIOL 1410)	3CR
Introduction to Entomology	(ENTM 2050)	3CR
The Dynamic Earth	(GEOL 1340)	3CR
Essentials of Microbiology	(MBIO 1220)	3CR

Optics	(PHYS 2260)	3CR

GROUP B – WINTER 2021		
Introduction to Astronomy: The Magnificent Universe	(ASTR 1810)	3CR
Introduction to Organic Chemistry	(CHEM 1320)	3CR
The Dynamic Earth	(GEOL 1340)	3CR
Introduction to Quantum Mechanics and Special Relativity	(PHYS 2386)	3CR
Classical Mechanics 1	(PHYS 2650)	3CR
Medical Physics and Physiological Measurements	(ECE 3580)	3CR

Course Descriptions: ELECTRICAL ENGINEERING

SECOND YEAR COURSE DESCRIPTIONS

Engineering Communication (ENG 2030 or ENG 2040) 3CR

Take only one of **ENG 2030**: Students work in a team-based environment to produce deliverables comparable to the engineering workplace. In-class tutorials focus on the sharpening of individual students' writing skills through an analytical, problem-solving and critical thinking approach. Students are exposed to a variety of communicative scenarios and emphasis is placed on development of a repertoire of skills necessary for effective communication in the engineering profession. **OR ENG 2040**: This team-based course focuses on a rhetorical approach, communication strategies and guided practice in the design of engineering communications. ENGL 1400/1310, ENG 1430 (or former ENG 2010) prerequisite.

Difficulty: 3 **Workload:** 5

Tips: Make sure to get started on your final report early to allow lots of time for editing. Wear business clothes for all presentations. Try to keep up with entries in your journal.

Engineering Mathematical Analysis 1 (MATH 2130) 3CR

Multivariable differential and integral calculus up to and including multiple integrals in cylindrical and spherical coordinates. For Engineering and Geophysics students only. Prerequisites: MATH 1210 or MATH 1211 and MATH 1710.

Difficulty: 3 **Workload:** 3

Tips: Make sure to review your notes from Calculus 2 before starting this class. The textbook has lots of practice problems, which are a great way to prepare for the tests. Make an effort to attend the tutorials, as the professors will go through practice problems.

Engineering Mathematical Analysis 2 (MATH 2132) 3CR

Infinite series, Taylor and Maclaurin Series; ordinary differential equations including Laplace transforms. For Engineering and Geophysics students only. MATH 1210 and MATH 1710 are prerequisites.

Difficulty: 4 **Workload:** 3

Tips: The best way to prepare for your midterms and final is to do lots of practice problems in the textbook. The tutorials are taught by the professor, so they are a great opportunity to go through additional practice problems and ask your questions.

Engineering Mathematical Analysis 3 (MATH 3132) 3CR

Vector integral calculus; series of ordinary differential equations; Fourier series and Partial differential equations. MATH 2130 and MATH 2132 are prerequisites.

Difficulty: 4 **Workload:** 3

Tips: Review your notes from Math 1 and 2 before starting this course. The textbook is an excellent source of practice problems for the midterm and final. The topics covered in Math 3 will be used in many of the third-year electrical engineering courses, so it is important to understand all the concepts covered in the class.

Electric Circuits (ECE 2262) 4CR

The application of circuit concepts; network theorems and formal methods, steady state analysis, frequency and transient response, application of the Laplace transform in the

analysis of linear time-invariant networks. Prerequisite: ENG 1450. Pre- or Co-requisite: MATH 2132.

Difficulty: 3.5 **Workload:** 3.5

Tips: Review your notes from ENG 1450. The concepts and analysis techniques you learn in the labs (such as the use of an oscilloscope and function generator) will be used throughout your degree. Practicing old exams and doing textbook problems are excellent ways to prepare for the midterm.

Digital Logic Systems (ECE 2220) 5CR

Boolean algebra and logic primitives, net-work simplification techniques, physical realizations, number systems and codes; analysis and design of asynchronous and synchronous sequential circuits; applications to computation, measurements, and control. Prerequisite ENG 1450.

Difficulty: 3 **Workload:** 4

Tips: This course includes an open-ended design project. Get started on it early to allow plenty of time for debugging. The TA's and Professors like to see creativity on the design project. The textbook for this course is very expensive but is an excellent source of practice problems, so it is worth the investment.

Ecology, Technology and Society (ANTH 2430) 3CR

Ecological analysis of the interplay of socio-political and technological processes in different types of societies. Focus upon the ecological side-effects and selected technologies, economic mechanisms and political institutions.

Difficulty: 2 **Workload:** 2

Tips: This course requires students to write several essays. If you send a draft of your essay to the TA, they will be able to give you comments and feedback before the final paper is due.

Modern Physics for Engineers (PHYS 2152) 3CR

An overview of topics in modern physics including wave particle duality, atomic structure and quantum mechanics. Elementary classical electromagnetic theory and wave theory are

reviewed as an introduction to the modern physics concepts. For Engineering students only. Not to be held with PHYS 1070 or PHYS 1071. Prerequisites: a “C” or better in one of PHYS 1050, and a “C” or better in MATH 1510; and a "C" or better in MATH 1710, or MATH 1690. Prerequisite or concurrent requirement: MATH 2130.

Difficulty: 3 **Workload:** 2

Tips: The midterm and final are both multiple choice. Practicing old exams (which are available in your lab manual) is an excellent way to prepare. Lab reports have to be handed in by the end of the lab section, so make sure to come prepared.

Numerical Methods for Electrical Engineers (ECE 2240) 4CR

Numerical methods applied to Electrical Engineering problems; mathematical models of physical systems, solutions of linear and non-linear equations, numerical differentiation and integration methods and associated errors, introduction to solution analysis. Prerequisites ECE 2262, COMP 1012, MATH 2132.

Difficulty: 3.5 **Workload:** 3.5

Tips: You are not provided with a formula sheet for the exams, so make sure to memorize all the necessary equations. All labs are completed on Matlab, so spend some time at the beginning of the semester learning basic Matlab syntax.

Electronics 2E (ECE 2160) 5CR

Characteristics of integrated circuits and transistors; design of DC and AC amplifiers in the steady state. Prerequisite: ECE 2262.

Difficulty: 3.5 **Workload:** 3.5

Tips: This course includes a design project. It is important to get started early to allow yourself plenty of time to work on your simulation, and then perform physical testing. Keep in mind that the actual behaviour of your circuit will be different than the simulation. Each semester an engineer in residence will be assisting with the design project. Ask lots of questions and consult them if you encounter problems with the design process.

Microprocessing Systems (ECE 3610) 4CR

Fundamentals of microprocessors and microcomputers; data flow; machine programming; architectures and instructions sets; stacks, subroutines, I/0, and interrupts; interfacing fundamentals; designing with microprocessors. Prerequisite: ECE 2220.

Difficulty: 3 **Workload:** 4

Tips: The labs for this course require students to code in assembly language. Make sure to prepare before the labs so that you are able to finish on time. Old midterms should be available on the course website and are an excellent way to prepare for the term tests.

THIRD YEAR COURSE DESCRIPTIONS

Foundations of Electromagnetics (ECE 3580) 4CR

Fundamental laws of field theory; Maxwell's equations in integral and point form. This course introduces students to electrostatics, magnetostatics and basics of electromagnetics. Prerequisite: ECE 2240, PHYS 2152, and MATH 3132.

Difficulty: 5 **Workload:** 4

Tips: The labs in this course are completed on Matlab. Make sure to review Matlab before the first lab, to ensure that you will be able to finish on time. In the past, this course has included 5 quizzes. Spend some time practicing the old quizzes and reviewing the concepts covered in class to prepare for them. There may also be a tutorial session each week. The tutorial is an excellent chance to practice additional problems and to get your questions answered. Old midterms are a good tool to prepare for the midterm and final, but make sure to review the course notes as well, as it is likely that your exams will include types of questions that are not on any of the old tests.

Contemporary Statistics for Engineers (STAT 2220) 3CR

Descriptive statistics, basic probability concepts, special statistical distributions, statistical inference-estimation and hypothesis testing, regression, reliability, statistical process control. Prerequisite: MATH 1710.

Difficulty: 2.5 **Workload:** 2