

ENGG*3450 - Electronic Devices

Fall 2024 Course Outline

Section: 01

Credits: 0.50

Land Acknowledgement: Guelph

The University of Guelph resides on the ancestral lands of the Attawandaron people and the treaty lands and territory of the Mississaugas of the Credit. We recognize the significance of the Dish with One Spoon Covenant to this land and offer respect to our Anishinaabe, Haudenosaunee and Métis neighbours. Today, this gathering place is home to many First Nations, Inuit, and Métis peoples and acknowledging them reminds us of our important connection to this land where we work and learn.

Calendar Description

This course explores the theory and principles of modern electronic devices and their applications in circuits. Course topics include: intrinsic and doped semiconductors; drift and diffusion currents; metal-semiconductor contacts and MOS capacitors; pn junctions and breakdown phenomena; solid-state diodes; bipolar and MOS field-effect transistors; current-voltage characteristics and biasing; small-signal models and operation; circuit integration; analysis and design of application circuits, operational transconductance amplifiers, and logic gates.

Prerequisite(s): ENGG*2450

Restriction(s): This is a Priority Access Course. Enrolment may be restricted to the BIOE, BME, CENG and ESC specializations in the BENG and BENG:C programs. See department for more information. Non-BENG students may take a maximum of 4.00 ENGG credits.

Department(s): School of Engineering

Lecture Schedule

MonWedFri 12:30pm-1:20pm in ROZH*102 (9/5 to 12/13)

Some lectures may be in AD-S format as needed and in such a case announcement will be made via courselink

Lab Schedule

Day	Time	Location	Sections
Monday	15:30 - 17:20	RICH 1504	0101-0201
Wednesday	15:30 - 17:20	RICH 1504	0102-0202
Friday	15:30 - 17:20	RICH 1504	0103-0203

Some tutorial/laboratory sessions may be in AD-S format as needed. Information will be announced via courselink.

Instructor Information

Mohamad Abou El Nasr

Email: maboueln@uoguelph.ca

Additional Support

Lab Technician

Hong Ma

hongma@uoguelph.ca RICH1506

Teaching Assistants

Teaching Assistant (GTA)

Email

TBD

Textbooks

Group	Title	Author	ISBN
Required	Microelectronic Circuits	A. S. Sedra, K. C. Smith, T. C. Carusone	
Suggested	Principles of Semiconductor Devices, Oxford, 2nd ed., 2011	S. Dimitrijevic	
Suggested	Microelectronics: Circuit Analysis and Design, McGraw-Hill, 4th ed., 2010	D. A. Neamen	

Learning Resources

Required Resources

Course materials, announcements, and grades will be posted to the course webpage on CourseLink (<http://courselink.uoguelph.ca>). You are responsible for checking the site regularly.

Course Resources

Readings (Readings)

Readings from the textbook will be posted on the course webpage. The readings are assigned with the intention that you will read them before class (so that you will be prepared to discuss the concepts and follow the examples presented in class) and that you will study them in preparation for the midterm and final exams (to strengthen the knowledge that you have gained through the course).

Lecture notes (Notes)

Lecture notes will be posted on the course webpage. The notes are prepared with the intention that you will fill in the blanks, take additional notes and write down examples in class. Attendance at lectures is expected, because materials, interpretations and examples not present in the notes will be discussed.

Problem sets (Other)

Problem sets will be available on the course webpage. The problems are selected with the intention that you will solve them throughout the term as a way to reinforce and self-assess your understanding of the topics in the course. You are expected to participate in the solution of some of the problems during the tutorials.

Laboratory manuals (Lab Manual)

Laboratory manuals will be posted on the course webpage. The manuals are prepared with the intention that you will read them before each laboratory session to be ready for a safe and successful activity, and that you will consult them during the laboratory while taking your own notes. Attendance at laboratories is mandatory.

Datasheets and instruction manuals (Other)

Datasheets of electronic components and instruction manuals will be available on the course webpage to be consulted in relation to the laboratory activity.

Campus Resources

If you are concerned about any aspect of your academic program: Make an appointment with a Program Counsellor (<https://www.uoguelph.ca/uaic/programcounsellors/>) in your degree program. If you are struggling to succeed academically: There are numerous academic resources offered by the Learning Commons (<https://www.lib.uoguelph.ca/using-library/spaces/learning-commons/>) including, Supported Learning Groups for a variety of courses, workshops related to time management, taking multiple choice exams, and general study skills.

Library Course Reserve (Ares)

Library resources (Textbook) The textbook and reference books are available from the University Bookstore (<https://www.bookstore.uoguelph.ca/>) (in printed or digital form) and are on Course Reserve (<https://ares.lib.uoguelph.ca/ares/>) (in printed form in the self-serve collection next to the Ask Us Desk in the library). Additional references are indexed by library call numbers TK7800 to TK8360.

Course Learning Outcomes

1. Relate the properties of semiconductor materials to the models of diodes and transistors, and describe the principles of operation of these devices.
2. Bias a circuit for linear operation, and solve circuit problems by applying device models and by executing mathematical operations based on the large-signal and small-signal abstractions.
3. Understand that you can use ideal models to predict the results of simulations or experiments, and identify in which aspects the behaviour of a device deviates from its model.
4. Apply analysis methods to evaluate the performance of circuits with diodes, transistors, gain stages and logic gates, identify the device parameters that determine the performance of gain stages and logic gates, and deduce functions from the combination of elements.
5. Comprehend the process of assembling and troubleshooting circuits on a breadboard, and the function of engineering tools for characterizing electronic devices.
6. Read and draw schematic diagrams, interpret data sheets of electronic devices, and communicate about performance of electronic components.

Course Level Learning Outcomes

This course is designed to help you with:

1. Gaining knowledge about the principles of operation of electronic devices and their applications in circuits.
2. Understanding the connections between device-level characteristics and circuit-level performance as the means to analyzing electronic circuits and designing applications that operate as desired.
3. Developing knowledge-integration, problem-solving and investigation skills as you prepare for your career in engineering

Teaching and Learning Activities

Lectures

Week	Dates	Lecture Topics	References	Outcomes
1	Sep. 5–6	—	—	—
	Sep. 9–13	Semiconductors and pn junctions	ch. 3	1
2	Sep. 16–20	Diodes	ch. 4	1, 2
3	Sep. 23–27	Diode circuits	ch. 4	2, 3, 4
4	Sep. 30 - Oct. 4	Transistors	ch. 5	1, 2
5	Oct. 7–11	Transistor circuits in dc	ch. 5	2, 3, 4
6	Oct. 14–18	Study break (Midterm)	—	—
7	Oct. 21–25	Signals and amplifiers	ch. 1	3, 4
8	Oct. 28–Nov. 1	Transistor amplifiers	ch. 7	4, 5, 6
9	Nov. 4–8	Transistor amplifiers	ch. 7	4, 5, 6
10	Nov. 11–15	Inverters	ch. 16	4, 5, 6
11	Nov. 18–22	Logic gates	ch. 16	4, 5, 6
12	Nov. 25–29	Review	—	—

Topics schedule will be adjusted throughout the course as needed.

5.2 Tutorials/Laboratories

Week	Dates	Topics	Due Date	Outcomes
	Sep. 5–6	—	—	—
1	Sep. 9–13	Laboratory 1 with report	Sep. 30	3, 5, 6
2	Sep. 16–20	Tutorial 1 with assignment	Oct. 7	2, 4
3	Sep. 23–27	Laboratory 1 (continued)	(Sep. 30)	3, 5, 6
4	Sep. 30 - Oct. 4	Tutorial 2 with assignment	(Oct. 7)	2, 4
5	Oct. 7–11	Laboratory 2 with report	Oct. 28	3, 5, 6
6	Oct. 14–18	Study break	—	—
7	Oct. 21–25	Laboratory 2 (continued)	(Oct. 28)	3, 5, 6
8	Oct. 28–Nov. 1	Tutorial 3 with assignment	Nov. 25	3, 5, 6
9	Nov. 4–8	Laboratory 3 with report	(Nov. 18)	3, 5, 6
10	Nov. 11–15	Laboratory 3 (continued)	Nov. 18	3, 5, 6
11	Nov. 18–22	Tutorial 4	(Nov. 25)	2, 4
12	Nov. 25–29	Revision	—	—

Topics schedule will be adjusted throughout the course as needed.

Assessment Breakdown

In order for your marks to be recorded correctly, all the accounts that you use in relation to the course must be associated to your University email address. You must sign in to the learning-management/distance-learning tools and identify yourself on your submissions using your first and last name as written on your student ID card. You are expected to use the CourseLink integration to sign in to the online grading tool and to enter video-conference meetings (when and if needed) because this facilitates the process. Submissions that cannot be attributed conclusively will not be graded; attendance that cannot be attributed conclusively (if required) will not be recorded. Technical difficulties during activities offered both in person and via web conferencing will not constitute grounds for academic consideration.

Name	Scheme A (%)
Laboratories	25
Assignments	15
Midterm exam	25
Final exam	35
Total	100

Assessment Details

Lab Activities

Laboratories

25%

Your proficiency with the laboratory activity will be assessed with three laboratory reports equally weighted. Please see "Teaching and Learning Activities" Section for schedule and due dates.

Course Learning Outcomes Assessed: 3, 5, 6

Assignment

Assignments

15%

Your ability to apply course concepts will be assessed by solving two sets of assigned problems, which will be equally weighted.

Course Learning Outcomes Assessed: 2, 4

Midterm

Midterm Exam

25%

Date: Sat, Oct 19, 12:00 PM - 2:00 PM

A closed-book midterm exam will include all the material covered in lectures, tutorials and laboratories to-date. Please verify the time, location and modality on the course webpage.

Course Learning Outcomes Assessed: 1, 2, 3, 4

Exam

Final Exam

35%

Day & Time: See "Final Exam" Section Below

A closed-book final exam will include all the material covered in lectures, tutorials and laboratories to-date. Please verify the time, location and modality on the course webpage.

Course Learning Outcomes Assessed: 1, 2, 3, 4

Final Exam

Date: Dec 2

Time: Mon 11:30am-1:30pm

Location: TBA *Please see Web Advisor closer to the date of scheduled final for location.*

To understand rules and regulations regarding Examinations students are encouraged to read Student's Responsibilities (<https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/examinations/>)

If the student is unable to meet the final exam requirements due to medical, psychological or compassionate circumstances they are encouraged to review Student's Responsibilities in the Academic Consideration, Appeals and Petitions (<https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/academic-consideration-appeals-petitions/>) section of the Academic Calendar.

Last Day to Drop Course

The final day to drop Fall 2024 courses without academic penalty is the last day of classes: November 29

After this date, a mark will be recorded, whether course work is completed or not (a zero is assigned for missed tests/assignments). This mark will show on the student's transcript and will be calculated into their average.

Course Grading Policies

Missed exams

Any student not taking an exam receives a grade of zero for that exam. There are no makeup midterm exams. If the midterm is missed due to grounds for granting academic consideration, the weight of the missed midterm will be added to the final exam.

Laboratory work

Attendance is mandatory for your laboratory reports to be accepted for marking therefore you are expected to work in the laboratory for the duration of your laboratory sessions and have your student ID card with you. If you arrive more than 15 minutes late, leave more than 20 minutes early, or fail to sign the attendance sheet, you will be considered absent. There are no laboratory exemptions or makeup laboratory sessions. In case you have a legitimate reason for missing a session, the instructor may consider an accommodation upon presentation of a suitable request.

Laboratory reports, assignments and exam papers

Any student not handing in a submission receives a grade of zero for that submission. There are no makeup submissions. In case you have a legitimate reason for missing a deadline, the instructor may consider an accommodation upon presentation of a suitable request. Consideration for remarking will only be allowed if brought to the attention of the instructor within a week of when results are released.

Submissions' compliance, technical assistance and back-up copies

When you upload a submission to the course webpage or through the online grading tool, you must verify that the file meets the requirements, is readable, and is the one you intended to upload. Non-complying submissions will not be accepted for marking. Non-complying submissions include late submissions, incomplete submissions, submissions in the wrong format, and submissions sent via email or other noncompliant ways. If you experience technical difficulties, you are expected to take the necessary steps to address the issue, seek appropriate technical assistance (e.g. by contacting the IT Help Desk or CourseLink Support), and inform the instructor immediately. Please keep reliable back-up copies of all your submissions, because you may be asked to resubmit your work.

Accommodation of Religious Obligations

If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of that requirement or as soon as you are aware of the conflict to make alternate arrangements. See the Academic calendar for information on regulations and procedures for Academic Accommodations of Religious Obligations (<https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/academic-accommodation-religious-obligations/>).

Course Standard Statements

Communication and Email Policy

Communication is through announcements during the lectures. Some information will be posted on the course webpage or sent via email messages to your University address. It is your responsibility to keep yourself informed about the course.

Please use lectures, tutorials and laboratory sessions as your main opportunity to receive information about the course. Please connect to the instructional team during the office hours when you have specific questions about concepts, problem sets, and laboratory experiments, and any question that cannot be answered easily or briefly with a reply email.

The course email policy is as follows:

- Use your university email account for correspondence relating to the course. Before starting, check if your question has been already answered on the course outline or webpage (e.g. through the Announcements tool).
- Start the subject header with the course identifier "ENGG*3450" and add the topic of your message.
- Include a clearly written message, your name and student number, and all the necessary information (e.g. the course section that you are registered in)
- You will normally receive a reply in a timely manner (with the exception of nights, weekends and holidays). If you do not receive a reply within two days, please resubmit your question or phone.

Relationships With Other Courses

Previous courses

PHYS*1010, Introductory Electricity and Magnetism:

Electric charges, fields and currents, electrical resistance and capacitance.

ENGG*2450, Electric Circuits:

Lumped-element models, node and mesh analysis, linearity and superposition, Thévenin and Norton theorems, operational amplifier, transformers, RLC circuits in dc, ac and transient conditions

Follow-on courses

ENGG*3490, Introduction to Mechatronic Systems Design:

Modelling and design of mechatronic systems with electronic and mechanical components.

ENGG*4080, Micro and Nano-Scale Electronics:

Integrated circuits, differential and multistage amplifiers, frequency response, design principles of micro and nano electronic circuits.

ENGG*4390, Bio-Instrumentation Design:

Electronic instrumentation and measurements for biological and biomedical systems.

ENGG*4550, VLSI Digital Design:

CMOS gates, latches, registers, pipelining, adders, multipliers, and shifters.

Recommendations About Studying

You are encouraged to spread the learning periods over the entire term (e.g. it is a good idea to start studying from today). Try to avoid distractions while studying and during lectures, tutorials and laboratory sessions. Take notes and outlines while reading or listening. Work on the assigned readings and problems regularly. Note down the questions that arise and get clarifications at the earliest possible time.

Obtaining Help

You can obtain help from the instructor during the office hours and from the teaching assistants and laboratory technician during the tutorial and laboratory time slots. Please contact the instructional support team if you need help or you have fallen behind in your work. They are willing to put in as much effort to help you as you are willing to put in to help yourself. They are happy to work with you on difficult concepts and to hear your suggestions for improving the course. If you are ill, please call the Health Services or a physician. If you have emotional, family, or living environment problems that affect your ability to study, please visit the Counselling Services or a counsellor. If you have a disability, please refer to the Accessibility Services. If you have other well-being concerns, please contact the Student Wellness Centre. You are encouraged to use the available services, and you are welcome to discuss with the instructional support team your specific learning needs in this course at the earliest possible time. It is your

responsibility to seek help, inform the instructor and consult the program counsellor in a timely manner when extenuating circumstances affect your academic performance.

Laboratory Policies and Safety

You have to follow the posted laboratory policies at all times, which include not letting unauthorized people in, not sharing your student ID card or your credentials, not wedging the laboratory doors open, and not bringing any food or drinks in the laboratory.

Before a laboratory session, you must read the materials posted on the course webpage. At the beginning of the first laboratory session, you must attend the mandatory safety orientation. Whenever you are in the laboratory, you have to use good judgement and safe working habits. In case of doubts about safety procedures, you must consult with the laboratory technician immediately. Please be advised that any violation of laboratory policies may result in loss of laboratory privileges.

Academic Integrity

Maintaining academic integrity is simple: you must not engage in any activity that will dishonestly improve your results or dishonestly improve or hurt the results of others. However, since the value of your academic degree depends on the integrity of your work, it is important that you familiarize yourself with your responsibilities, review the tutorial on academic integrity, and discuss any question that you may have with the instructor. The instructor will follow up on academic misconduct concerns as per university policy and out of respect to all the students who are maintaining their academic integrity.

All your submissions for this course must be the product of your own independent work. When writing an exam, a report or an assignment, please remember that copying text, data, or figures is plagiarism, even if you received the material from a friend, if you found the material on the Internet (including learning apps, answer-sharing platforms and AI chatbots), or if you are reusing material for which you have previously received credit. Letting other students use your work, completing work for other students, engaging in contract cheating or making answers available to others (including answers written by you, like graded assignments, reports and exams, and answer keys and materials provided by course staff or other sources) are also not allowed. Therefore, please keep your submissions, drafts and data in a secure location.

Information

The Academic Misconduct Policy is detailed in the Undergraduate Calendar (<https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulationsprocedures/academic-misconduct/>):

A tutorial on Academic Integrity can be found HERE (<https://guides.lib.uoguelph.ca/academicintegrity/>)

Turnitin

In this course, Turnitin will be used to detect possible plagiarism, unauthorized collaboration and copying as part of the ongoing efforts to maintain academic integrity at the University of Guelph.

All submissions will be included as source documents in the Turnitin.com reference database solely for the purpose of detecting plagiarism of such papers. Use of the Turnitin.com service is subject to the Usage Policy posted on the Turnitin.com site.

Acceptable Use of Course Resources

The instructor reserves the right to all materials made available for this course and all interpretations presented, which may not be reproduced, retained, or transmitted to others without the written consent of the instructor. Audio or video recordings of lectures and teleconference sessions are not allowed without the written consent of the presenter. Third-party copyrighted materials have either been licensed for use in this course or have been copied under an exception or limitation in Canadian copyright law. All the course materials, including the materials available on the course webpage and on Course Reserve, and all the contents distributed or generated during classes, laboratories, tutorials and exams are only for the use of students enrolled in this course for the purposes associated with this course and may not be further disseminated or retained beyond the duration of this course. Your use of course materials and resources must conform to applicable license agreements and Canadian copyright law. Your access and use of information technology resources must comply with the University of Guelph Acceptable Use Policy and with applicable agreements. You are encouraged to discuss any question you may have with the instructor.

This course outline includes sections and standard statements adapted with permission from course outline templates of the School of Engineering and from the course outline checklist of the University of Guelph.

School of Engineering Statements

Instructor's Role and Responsibility to Students

The instructor's role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on

Courselink but these are not intended to be stand-alone course notes. Some written lecture notes will be presented only in class. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and labs.

Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and lab sessions. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

Lab Safety

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible

Standard Statements for Undergraduate Courses

Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community – faculty, staff, and students – to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

The Academic Misconduct Policy (<https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/academic-misconduct/>) is outlined in the Undergraduate Calendar.

Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability. Use of the SAS Exam Centre requires students to make a booking at least 10 days in advance, and no later than the first business day in November, March or July as appropriate for the semester. Similarly, new or changed accommodations for online quizzes, tests and exams must be approved at least a week ahead of time. For students at the Guelph campus, information can be found on the SAS website. (<https://www.uoguelph.ca/sas/>)

Accommodation of Religious Obligations

If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements.

See the Academic calendar for information on regulations and procedures for Academic Accommodations of Religious Obligations (<https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/academic-accommodation-religious-obligations/>).

Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all undergraduate students except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available

in the Undergraduate Calendar - Dropping Courses (<https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/dropping-courses/>).

Email Communication

As per university regulations, all students are required to check their <uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its students.

Health and Wellbeing

The University of Guelph provides a wide range of health and wellbeing services at the Vaccarino Centre for Student Wellness (<https://wellness.uoguelph.ca/>). If you are concerned about your mental health and not sure where to start, connect with a Student Wellness Navigator (<https://wellness.uoguelph.ca/navigators/>) who can help develop a plan to manage and support your mental health or check out our mental wellbeing resources (<https://wellness.uoguelph.ca/shine-this-year/>). The Student Wellness team are here to help and welcome the opportunity to connect with you.

Illness

Medical notes will not normally be required for singular instances of academic consideration, although students may be required to provide supporting documentation for multiple missed assessments or when involving a large part of a course (e.g., final exam or major assignment).

Recording of Materials

Presentations that are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

Resources

The Academic Calendars (<http://www.uoguelph.ca/registrar/calendars/?index>) are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs.

When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. See the Undergraduate Calendar for information on regulations and procedures for Academic Consideration. (<https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/academic-consideration-appeals-petitions/>)

Professional Accreditation Outcomes

Engineers Canada - Graduate Attributes (2018)

Successfully completing this course will contribute to the following:

1. Knowledge Base

	Graduate Attribute Indicator	Instructional Level	Data Collection for Accreditation
1.3	Recall, describe and apply fundamental engineering principles and concepts	Advanced	No
1.4	Recall, describe and apply program-specific engineering principles and concepts	Advanced	Yes

2. Problem Analysis

	Graduate Attribute Indicator	Instructional Level	Data Collection for Accreditation
2.3	Construct a conceptual framework and select an appropriate solution approach	Developed	No

3. Investigation

	Graduate Attribute Indicator	Instructional Level	Data Collection for Accreditation
3.2	Design and apply an experimental plan/investigative approach (for example, to characterize, test or troubleshoot a system)	Developed	No
3.3	Analyze and interpret experimental data	Developed	No

4. Design

	Graduate Attribute Indicator	Instructional Level	Data Collection for Accreditation
4.2	Construct design-specific problem statements including the definition of criteria and constraints	Developed	No

5. Use of Engineering Tools

	Graduate Attribute Indicator	Instructional Level	Data Collection for Accreditation
5.2	Demonstrate proficiency in the application of selected engineering tools	Developed	Yes
5.3	Recognize limitations of selected engineering tools	Developed	No

7. Communication Skills

	Graduate Attribute Indicator	Instructional Level	Data Collection for Accreditation
7.2	Interpret technical documentation such as device specification sheets, drawings, diagrams, flowcharts, and pseudocode	Developed	No
7.3	Construct the finished elements using accepted norms in English, graphical standards, and engineering conventions, as appropriate for the message and audience	Developed	No