I. Writing Plan Cover Page

Please fill in the gray areas on this form.

April 13, 2018


Department of Electrical and Computer Engineering (ECE)

<table>
<thead>
<tr>
<th>WEC Unit Name</th>
<th>College of Science and Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical and Computer Engineering</td>
<td></td>
</tr>
<tr>
<td>Department</td>
<td>College</td>
</tr>
<tr>
<td>David Orser</td>
<td>Teaching Assistant Professor</td>
</tr>
<tr>
<td>WEC Faculty Liaison (print name)</td>
<td>Title</td>
</tr>
<tr>
<td><a href="mailto:orser@umn.edu">orser@umn.edu</a></td>
<td>612-212-2156</td>
</tr>
</tbody>
</table>

Email

Writing Plan ratified by Faculty

Note: This section needs to be completed regardless of Writing Plan edition.

Date: 4/12/2018

If Vote: 6 / 6

Process by which Writing Plan was ratified within unit (vote, consensus, other- please explain):

ECE Curriculum Committee reviewed the 2nd Edition Writing Plan and voted to approve
II. **Unit Profile**: ECE

*Please fill in the gray areas on this form.*

**Number of Tenured and Tenure-Track Faculty:**

<table>
<thead>
<tr>
<th>Faculty Type</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professors</td>
<td>28</td>
</tr>
<tr>
<td>Associate Professors</td>
<td>6</td>
</tr>
<tr>
<td>Assistant Professors</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
</tr>
</tbody>
</table>

In addition to 47 Tenure and Tenure-Track Faculty there are **three** full-time teaching faculty and **three** part-time teaching or emeritus faculty.

**Major(s)**

*Please list each major your Unit offers:*

<table>
<thead>
<tr>
<th>Major Description</th>
<th>Total # students enrolled in major as of Fall 2017</th>
<th>Total # students graduating with major AY 16-17</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Engineering (intended + declared)</td>
<td>307+83</td>
<td>110</td>
</tr>
<tr>
<td>Computer Engineering (intended + declared)</td>
<td>229+54</td>
<td>77</td>
</tr>
</tbody>
</table>

**WEC Implementation Process**

<table>
<thead>
<tr>
<th>Process</th>
<th>Semester/Year- Semester/Year</th>
<th># participated</th>
<th># invited</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab Notebook Rubric Discussion</td>
<td>September 15, 2017</td>
<td>8 / 24</td>
<td></td>
</tr>
<tr>
<td>Faculty Lunch and Learn Improving Students Lab Report and Presentations</td>
<td>October 10, 2017</td>
<td>12 / 53</td>
<td></td>
</tr>
<tr>
<td>Lab Report Rubric Discussion</td>
<td>October 30, 2017</td>
<td>3 /</td>
<td></td>
</tr>
<tr>
<td>Faculty Lunch and Learn Discussion on Final Lab Report+Notebook, TA Training, and Special Lab Sessions for students</td>
<td>December 04, 2017</td>
<td>8 / 15</td>
<td></td>
</tr>
<tr>
<td>TA Training Lab Reports</td>
<td>December 08, 2017</td>
<td>12 /</td>
<td></td>
</tr>
<tr>
<td>TA Training Lab Notebook</td>
<td>January 19, 2018</td>
<td>6 / 6</td>
<td></td>
</tr>
<tr>
<td>Title</td>
<td>Date</td>
<td>Score</td>
<td>Max Score</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>------------------</td>
<td>-------</td>
<td>-----------</td>
</tr>
<tr>
<td>Lab Notebook Rubric review for EE2002</td>
<td>January 26, 2018</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Lab Notebook Rubric review for EE3101</td>
<td>February 27, 2018</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Coding styles coding guidelines, CS and ECE - WEC teams</td>
<td>February 27, 2018</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Coding styles coding guidelines, ECE faculty</td>
<td>March 27, 2018</td>
<td>4</td>
<td>8</td>
</tr>
</tbody>
</table>
III. Signature Page

*Signatures needed regardless of Writing Plan edition. Please fill in the gray areas on this form.*

If this page is submitted as a hard copy, and electronic signatures were obtained, please include a print out of the electronic signature chain here.

**WEC Faculty Liaison**

David Orser

WEC Faculty Liaison (print name)

Signature

Teaching Assistant Professor

Title

April 12, 2018

Date

**Department Head/Chair**

Randall Victoria

Print Name

Randall Victoria

Signature

Professor & Head

Title

April 12, 2018

Date

**Associate Dean**

Paul J. Strykowski

Print Name

Signature

Professor of Mechanical Engineering

Associate Dean for Undergraduate Programs

Title

April 13, 2018

Date
IV. Writing Plan Narrative, 2\textsuperscript{nd} Edition

Please retain section headers and prompts in your plan.

\textbf{Introductory Summary:}

Briefly describe the reason(s) this unit (department, school, college) become involved in the WEC project, the key findings that resulted from the process of developing this plan, and the implementation activities that are proposed in this Writing Plan, with particular attention to the following questions: what is new in this 2\textsuperscript{nd} edition of the Writing Plan? What, if any, key changes have been made to the 1\textsuperscript{st} edition? What key implementation activities are proposed in this edition of the Writing Plan? (1 page maximum)

The Electrical and Computer Engineering (ECE) faculty recognize that written communication skills are of paramount importance to graduates in our field. Success in engineering is not just determined by a graduate’s technical capability to develop ideas or interpret data, but also by their ability to communicate a proposed solution clearly to managers, executives, the public, and engineering peers.

There are currently three writing intensive courses within the ECE department, of which only one is required for graduation (Senior Design). With the implementation of this plan, the ECE department intends to bring a more comprehensive approach to writing instruction, throughout our curriculum, by embedding specific written communications assignments in the curriculum. The embedding of specific writing assignments will provide additional fixed opportunities for students to practice and improve their writing skills as they progress through the degree programs.

Faculty participation in the WEC self-study process identified a broad recognition that ECE students are evaluated most heavily on technical knowledge. Furthermore, there was agreement that writing and communication skills are of critical importance in industry, often providing significant career advancement opportunities. Our students get opportunities to exercise these writing skills in senior design, but often it comes too late in the curriculum.

During the first year of implementation, the faculty will meet to review current writing assignments and identify additional areas within the curriculum to improve instruction of writing. The WEC liaison, WEC consultant, and WEC RA will develop improved writing rubrics and samples for use in teaching and in training of TAs. TA training materials will be prepared and disseminated throughout this year.
Section 1: DISCIPLINE-SPECIFIC WRITING CHARACTERISTICS

What characterizes academic and professional communication in this discipline?

☒ There have not been substantial revisions to this section of the Writing Plan.
☐ There have been substantial revisions to this section of the Writing Plan. (Discuss these explicitly.)

Exceptional writing in electrical and computer engineering doesn’t simply state a mathematical answer but should tell a story. Telling a story is important as it engages the reader, sets expectations, presents content, and summarizes findings. This concept is clearly applicable within formal papers but is also broadly applicable. Even basic circuit problem sets can find a foundation in this concept. For example, restating the problem or redrawing a circuit schematic “sets expectations,” intermediate work “presents the content,” and boxing an answer “summarizes the finding.”

During the self-assessment meetings the faculty gathered the following characteristics of writing in ECE:

- Tells a story and doesn’t merely offer a mathematical answer
- Focused; Provides as much information as necessary and no more
- Provides necessary context for understanding technical and mathematical answers
- Clear explanation of processes, mechanisms, analyses, and findings
- Appropriate visual modes for describing solutions (diagrams, tables, charts, figures)
- Visually are clear; include captions, labels, and symbols
- Clearly stated assumptions
- Coherent- structured and oriented toward a purpose
- Uses technologies of writing well (Excel, LaTeX, etc.)
- Uses writing to boil down to an issue and justify conclusions
- Impacts and consequences tied to audience
- Representative of professional standards and practices
- Documents development of ideas, steps in process, and variations/decisions
- Consistent style (consistent in first and third person)

More broadly, when presenting content, there are three areas the above characteristics can be grouped into:

- **Observing and reporting data clearly**, while communicating the assumptions and limitations of that data
- **Draw conclusions and persuade audiences**, in a method relevant and appropriate to the targeted audience
- **Utilizing professional standards and practices** to produce high-quality writing
Section 2: DESIRED WRITING ABILITIES
With which writing abilities should students in this unit’s major(s) graduate?

☒ There have not been substantial revisions to this section of the Writing Plan.
☐ There have been substantial revisions to this section of the Writing Plan. (Discuss these explicitly.)

The Department of Electrical and Computer Engineering understands writing as an iterative process central to engineering. Whether in homework, laboratories, or formal papers, students will report data accurately, draw well-supported conclusions, and will follow standards and expectations for writing in industry and academia.

Report data and observations

• Synthesize information from sources of data and evidence, including limits on available data
• Provide sufficient explanation for technical answers, such that it can be understood by particular audiences (peer level, non-technical, stakeholders)
• Provide clear explanation of processes, mechanisms, analyses, and findings
• Select appropriate visual modes for describing data and observations.

Draw conclusions and persuade audiences

• Tell a coherent story: Set the purpose and context, establish motivation or research question
• Identify and explain the impacts of technical data in ways that are meaningful to intended audience.
• Structure documents to draw well-supported conclusions; avoid tangents and irrelevant information.
• Use engineering data, evidence, and reasoning to persuade specific audiences.

Demonstrate attention to professional standards and practices

• Grammar, mechanics, punctuation, spelling
• Citation practices (quotation, paraphrase, figure captions)
• Ethics (avoid plagiarism and research misconduct)
• Follow expected publication standards (Professional journal guidelines, employer’s documentation standards, etc.)
Section 3: INTEGRATION OF WRITING INTO UNIT’S UNDERGRADUATE CURRICULUM

How is writing instruction currently positioned in this unit’s undergraduate curriculum (or curricula)? What, if any, course sequencing issues impede an intentional integration of relevant, developmentally appropriate writing instruction?

☒ There have not been substantial revisions to this section of the Writing Plan.
☐ There have been substantial revisions to this section of the Writing Plan. (Discuss these explicitly.)

The current structure of writing in ECE is focused around the Junior Labs and a Senior Design (WI) course. Students are required to take University Writing (WRIT 1301) and Senior Design (EE 4951W), plus three more WI courses. The junior level labs (EE3101 and EE3102) provide instruction in the development of lab notebooks and written lab reports. Senior Design provides for some opportunities to develop a broader range of writing skills, short memos, presentations, marketing focused pitches, etc. However, Senior Design is the final course in ECE and students are often unprepared to excel at these necessary skills.

Additional opportunities for writing are present in other courses, but these opportunities are inconsistent and dependent on the emphasis of the professor teaching the course.

What, if any, course sequencing issues impede an intentional integration of relevant, developmentally appropriate writing instruction?

Transfer students and ESL students are common in Sophomore and Junior level students. These students vary more in incoming writing skill and will be less impacted by changes to lower level courses.

Section 4: ASSESSMENT OF STUDENT WRITING

What concerns, if any, have unit faculty and undergraduate students voiced about grading practices?

Please include a menu of criteria extrapolated from the list of Desired Writing Abilities provided in Section II of this plan. (This menu can be offered to faculty/instructors for selective adaptation and will function as a starting point in the WEC Project’s longitudinal rating process.).

☒ There have not been substantial revisions to this section of the Writing Plan.
☐ There have been substantial revisions to this section of the Writing Plan. (Discuss these explicitly.)

Please include a menu of criteria extrapolated from the list of Desired Writing Abilities provided in Section 2 of this plan. (This menu can be offered to faculty/instructors for selective adaptation and will function as a starting point in the WEC Project’s longitudinal rating process.).
<table>
<thead>
<tr>
<th>Faculty-generated list of writing abilities expected of ECE students</th>
<th>Faculty generated evaluative criteria (What observable textual features can be used to evaluate the students’ ability?)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The student...</td>
<td>The text...</td>
</tr>
</tbody>
</table>

### Report data and observations

1. Synthesize information from sources of data and evidence, including limits on available data

- Describes the sources from which data is derived.
- Distills the data to a subset supporting the conclusion.
- Explicitly discusses contradictory data and sources of error or noise.

2. Provides clear and sufficient explanation for technical data, processes, mechanisms, analyses, and observations

- Includes information about the starting point (provided technical information)
- Addresses related engineering concepts that impact method for obtaining data, analyses, and resulting observations.
- (additional criteria for oral assignments) offer a verbal explanation of technical answers, particularly in lab contexts.

3. Select appropriate visual modes for describing data and observations

- Includes graphs that summarize data.
- Uses clear format—title, axis, units are labeled and standard.
- Includes schematics that are consistent with professional expectations (no crossed wires, values expressed appropriately).

### Draw conclusions and persuade audiences

4. Tell a coherent story: Set the purpose and context, establish motivation or research question

- Explicitly states purpose and motivation, particularly in formal documents.
- States the problem or redraws the circuit, particularly for informal documents or homework.

5. Identify and explain the impacts of technical data in ways that are meaningful to intended audience

- Adapts choices in language, vocabulary, and technical detail to the intended audience.
- Identifies common concepts understood between writer and reader then connects them meaningfully to conclusions.
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Structure documents to draw well-supported conclusions; avoid tangents and irrelevant information</td>
<td>Provides a structured narrative (introduction, body, conclusion). Contains no extraneous material.</td>
</tr>
<tr>
<td>7. Use engineering data, evidence, and reasoning to persuade specific audiences</td>
<td>Emphasizes key features and results relevant to specified audience to persuade (such as technical specifications, cost/benefit, and intangibles)</td>
</tr>
<tr>
<td><strong>Demonstrate attention to professional standards and practices</strong></td>
<td></td>
</tr>
<tr>
<td>8. Grammar, mechanics, punctuation, spelling</td>
<td>Contains no errors that could introduce ambiguity. Contains few, if any minor errors.</td>
</tr>
<tr>
<td>9. Citation practices (quotation, paraphrase, figure captions)</td>
<td>Uses paraphrase in a manner consistent with the writing in the field (no direct quotations) Consistent with its method of citation throughout the document (meets course stylesheet if provided.)</td>
</tr>
<tr>
<td>10. Ethics (avoid plagiarism and research misconduct)</td>
<td>Cites unique conclusions. Cites all figures, words, etc. extracted from other sources. Identifies roles and follows instructor guidelines for collaborative assignments.</td>
</tr>
<tr>
<td>11. Follow expected publication standards (Professional journal guidelines, employer's documentation standards, etc.)</td>
<td>Follows patent documentation standards as it relates to lab notebooks. Looks like NSF, NIH, DOD proposal or journal template, as assigned.</td>
</tr>
</tbody>
</table>
Section 5: SUMMARY OF IMPLEMENTATION PLANS, including REQUESTED SUPPORT and RELATION TO PREVIOUS IMPLEMENTATION ACTIVITIES

What does the unit plan to implement during the period covered by this plan? What forms of instructional support does this unit request to help implement proposed changes? What are the expected outcomes of named support?

How do the implementation plans of the 2nd edition Writing Plan relate to implementation activities from the 1st edition Writing Plan? What has been successful? What was not successful? How do implementation plans build on what was learned from the first year of implementation?

In the last year, ECE implemented the three improvement activities outlined in our first writing plan. This included a total of 11 WEC oriented meetings as of April 2018, the generation of a number of high-quality student facing documents, TA training seminar, and presentation templates for Instructor/TA’s to use while presenting assignments to students.

Of the three implementation activities outlined in the first edition writing plan, the first produced six documents covering the writing-oriented junior-level lab EE3101. These documents include two major assignment types, lab reports and lab notebooks. For each of these, we developed a 1-page overview, a detailed grading rubric, and a student accessible annotated examples document.

The second, faculty participated in focused discussions of current practices to identify new ways to implement more structured instruction on communications skills within the ECE curriculum. During two Lunch’n’Learns held so far (another planned for this May) we identified coding guidelines, outlined skill building techniques, and discussed plans to implement lab report and lab notebook support materials and the forms those materials should take.

Third, training for fair and efficient grading of writing was discussed with the relevant faculty. The core concepts developed in the WEC Writing Plan, plus specific implementation examples were created by the WEC TA and presented during the Spring 2018 teaching assistant orientation.

An extra implementation activity was identified in the fall Lunch’n’Learn sessions. The concept was to develop a coding guideline document for the department that could be applied broadly to several of our courses (EE1301, EE2301, EE2361, and additional senior-level electives.) During the spring term, this idea was fleshed out first by meeting with the Computer Science WEC Liaison (Phil Barry) and his WEC RA. Then further refined and tuned to ECE needs by a small group of CE faculty. The first edition of this implementation activity continues and should be complete by the end of the Spring 2018 semester.

While all the activities were at least moderately successful, direct implementation activities between the WEC RA and WEC Liaison were the most productive. Broad faculty feedback was instructive but required getting together again with directly interested faculty and further refining the ideas, then the WEC RA and WEC liaison implemented them.

Going forward over the next two years the plan will be to continue with only one broad Lunch and Learn each semester but focus on more small group meetings to get momentum on specific implementation ideas. As per annum funding is reduced in the second two years of the WEC program, we are asking for the WEC RA to be applied in the fall semester as the WEC Liaison has more available time during that semester.
Specific implementation activities that are currently planned are:

1.) Modification and expansion of the ECE Lab Report and ECE Lab Notebook materials to cover additional similar courses (EE2002, EE3006).
2.) 2nd edition of the ECE Coding Guidelines and expansion to cover multiple courses.
3.) Any additional activities identify in faculty Lunch’n’ Learns (one per semester) or faculty retreats (one per year)

**Section 6: PROCESS USED TO CREATE THIS WRITING PLAN**

How, and to what degree, were stakeholders in this unit (faculty members, instructors, affiliates, teaching assistants, undergraduates, others) engaged in providing, revising, and approving the content of this Writing Plan?

The first edition writing plan was introduced to the majority of the faculty at a full faculty meeting in April 2017. It was developed by the WEC liaison, department head, and associate head and a group of faculty that regularly teach undergraduate level courses.

The second edition writing plan was adapted from the first edition and is largely a continuation of that plan. The development of new implementation activities is an interactive process where a broad group of faculty was solicited for ideas on implementation activities. Then a smaller group of faculty are leveraged to work out the details of the implementation activity. This process will continue over the next two years.
V. WEC Research Assistant (RA) Request Form

This form is required if RA funding is requested. If no RA funding is requested please check the box below.

☐ No RA Funding Requested

RAs assist faculty liaisons in the WEC Writing Plan implementation process. The specific duties of the RA are determined in coordination with the unit liaison and the WEC consultant, but should generally meet the following criteria: they are manageable in the time allotted, they are sufficient to their funding, and they have concrete goals and expectations (see below).

RA funding requests are made by appointment percent time (e.g., 25% FTE, 10% FTE, etc.). Appointment times can be split between two or more RAs when applicable (e.g., two 12.5% appointments for a total of 25% FTE request). Total funds (including fringe benefits when applicable) need to be calculated in advance by the liaison, usually in coordination with administrative personnel.

Please note that, outside of duties determined by the liaison, WEC RAs may be required to participate in specific WEC activities, such as meetings, Moodle discussion boards, and surveys.

RA Name (Use TBD for vacancies): TBD
RA Contact Information: email TBD, phone TBD
Period of appointment (Semester/Year to Semester/Year): Fall/2018, Fall/2019
RA appointment percent time: 25% FTE

Define in detail the tasks that the RA will be completing within the funding period:
The research assistant will develop and present materials for the improvement of grading of writing assignments within the ECE department. These materials are to target faculty, students, and teaching assistants (TAs) and be developed in conjunction with relevant area faculty and the WEC liaison.

The following tasks will occur each fall:

- Facilitate, attend, and document all implementation activities
- Co-lead TA training sessions
- Document and disseminate outputs of implementation activities
- Develop and revise additional materials for students as defined by faculty in LnL’s
- Other tasks related to WEC activities as needed

The following tasks should be completed by the end of the Fall term 2018:

- Revise and update the coding guidelines for EE1301, EE2301, and EE2361
- Revise the grading rubrics for the Lab Notebook and Lab Reports, such that they cover EE2002, EE3006 under advice of relevant faculty and as applicable
• Revise instructional grading criteria that can be shared with students in submission for EE2002 and EE3006
• Improve TA training materials and present at TA orientation

During the fall 2019 term, based on faculty feedback during lunch and learn sessions, additional grading rubrics and training materials will be developed for key courses in the ECE curriculum. These will be completed by the end of the fall 2019 term.

Define deadlines as applicable (please note that all deadlines must be completed within the funding period):
Deadlines are defined in the section above.

Describe how frequently the RA will check in with the liaison:
Weekly status meetings with the WEC liaison will be expected.

Describe in detail the RA’s check-in process (e.g., via email, phone, in-person, etc.):
Weekly in-person meetings should be the norm. In the event travel or other exceptional circumstances, an online-chat or phone call can be used to provide weekly status updates.
Appendix – ECE Writing Plan Outputs – AY17/18

1.) ECE Lab Notebook
   a. One-page Overview
   b. Rubric
   c. Examples of Student Work

2.) ECE Lab Report
   a. One-page Overview
   b. Rubric
   c. Examples of Student Work

3.) ECE Coding Style Guide – Work-in-Progress (WIP)
   a. Initial 3-page overview with descriptions
Your lab notebook is a sequential log of your activities. It should tell the story of your adventures in the lab. It is designed to allow you and other practicing engineers to repeat your experiments in the future and evaluate your conclusions.

A notebook is NOT a polished report. Your writing should be a natural part of performing the experiment. You will make mistakes, note the blunder and start again. Small grammar and spelling errors are expected and acceptable; English that is incomprehensible is not. If your handwriting or sketching skills are poor, add printed diagrams and plots to your notebook after the fact. Some plots may require advance analysis/plotting, leave room for printed additions.

Each lab is generally divided into logical sections, containing a single circuit that is analyzed for a particular reason. Each section of the lab should be contained in a section of your lab notebook, with an introduction, procedure, and results detailed within.

For each section or logical group of sections within the lab:

I. Introduction
   - Describe purpose of the experiment
   - Draw schematics of the setup
   - Explain underlying theory
   - Discuss expected results or hypotheses

II. Procedure
   - Describe step by step process carried out
   - Record experimental data in the form of tables and plots
   - Show calculations and formulas utilized

III. Results
   - Summarize findings
   - Analyze sources of error

General Organization and Formatting
A. Draw complete circuit & equipment schematics
   - Show real world connections, annotate equipment, add relevant parasitics, measurement points, etc.
B. Label charts/figures/plots/diagram
   - Title and labeled axes with units
C. Actual component and used component values
D. Title, date, name (At top of each lab)

After reviewing this document, please see the grading Rubric and the Examples of student work documents.
This grading rubric is part of the Lab Notebook Guidelines. Please read the Overview document first, then review this document, and finally read the Examples of student work document.

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Inadequate</th>
<th>Good</th>
<th>Excellent (in addition to Good)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose of the experiment</td>
<td>Copying the given question/Writing one line description</td>
<td>Brief description without paraphrasing</td>
<td>Well organized paraphrasing of the purpose</td>
</tr>
<tr>
<td>Draw schematics of setup</td>
<td>Missing or copied from Lab manual</td>
<td>Redrawn schematic (see Miscellaneous)</td>
<td>Measurement points included</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Equipment parasitics included</td>
</tr>
<tr>
<td>Explain underlying theory</td>
<td>No adequate details about the underlying theory mentioned</td>
<td>Briefly describes theoretical background necessary to understand this section</td>
<td>Formulates theory specific to this physical implementation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Derives formulas that are unique to this application</td>
</tr>
<tr>
<td>Discuss expected results or hypotheses</td>
<td>No objectives stated</td>
<td>States the expected output</td>
<td>Identifies expected outputs and states assumptions if any</td>
</tr>
<tr>
<td>Item Description</td>
<td>Inadequate</td>
<td>Good</td>
<td>Excellent (in addition to Good)</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Step by step procedure</td>
<td>Only writes the step numbers</td>
<td>Record the chronological steps to complete the lab section</td>
<td>Record the actions to double check measurements and verify/debug the procedure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Describes the physical implementation of measurements</td>
<td></td>
</tr>
<tr>
<td>Record the experimental data</td>
<td>Data missing or incomplete</td>
<td>Recorded data are only shown in tables</td>
<td>Key data are summarized using tables, charts and plots (see Miscellaneous)</td>
</tr>
<tr>
<td>Show calculations and formulas</td>
<td>Results are directly written with explanation.</td>
<td>Formulas are recorded. Notations indicate where formulas are utilized in intermediate data and results.</td>
<td></td>
</tr>
</tbody>
</table>
## Results

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Inadequate</th>
<th>Good</th>
<th>Excellent (in addition to Good)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summarize findings</td>
<td>Results not clearly identified</td>
<td>Findings are clearly stated</td>
<td></td>
</tr>
<tr>
<td>Analyze sources of error</td>
<td>The sources of error/s are not addressed</td>
<td>The final error is calculated and recorded</td>
<td>Attempts have been made to minimize or compensate for sources of error</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Explains and quantifies some sources of error</td>
<td></td>
</tr>
</tbody>
</table>
### Miscellaneous

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Inadequate</th>
<th>Good</th>
<th>Excellent (in addition to Good)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Circuit and equipment schematic</strong></td>
<td>Missing or incomplete schematic</td>
<td>Schematics include actual lab connections</td>
<td>Equipment parameters and relevant parasitics included</td>
</tr>
<tr>
<td></td>
<td>Ex: breadboard, cables, etc.</td>
<td>Ex: Source impedance, probe capacitance, etc.</td>
<td></td>
</tr>
<tr>
<td>Charts/Tables/plots</td>
<td>Raw data of results only</td>
<td>Raw data captured in the form of tables with column units</td>
<td>Annotate tables with units, calculated values, errors, and to emphasis results</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Charts contain titles, axis labels, and units</td>
</tr>
<tr>
<td>Idea and actual component values</td>
<td>Records only ideal values for components</td>
<td>Explicitly records implementation of actual component to implemented value</td>
<td></td>
</tr>
<tr>
<td>Name of the author, date and lab experiment number</td>
<td>No Name (please go back and start again in Kindergarten)</td>
<td>Clearly mentions the name of the author, experiment, and date.</td>
<td></td>
</tr>
</tbody>
</table>
ECE: Lab Notebook Guidelines

WEC

Examples of Student Work with Comments
This “Examples” handout (like the Rubric and Overview) is organized into: Introduction, Procedure, and Results/Conclusions. In each, you will find examples of Inadequate, Good, and Excellent previous student work with comments from TAs and Professors.

Remember, each lab will need to be broken up into logical sections (based around an experimental setup, a circuit under test, or a particular question you are attempting to answer.) These logical sections will not be the same as the procedural steps in the lab manual. It is up to you to determine these logical sections, before lab starts. (You did read the lab manual before class right?!) Each logical section should have an introduction, procedure and results/conclusion.

**Introduction**

- Describe the overall goals of this logical section. What is it that you are trying to accomplish or determine with the experiment? – limit to 1 or 2 sentences
- Do not forget to include key mathematical formulas that form the basis of the experiment in this section.

**Example 1 - Good**

- Paraphrases the question
- A brief introduction
- Outlines the next things to be done

---

(1) A Brief Purpose

**Experiment #6: Operational Amplifiers**

1. This experiment is to determine the low frequency open loop gain for the LM741 op amp chip. The circuit diagram is shown below. The circuit considers the op amp to have an infinite input resistance. Using Kirchhoff's current and voltage laws we can find the op amp open loop gain.

(2) How he/she plans to proceed
Example 2 - Inadequate

- Unclear purpose
- No theoretical background seen

Example 3 - Excellent

- Gives good background info about opamp
- Lists applications
- Lists goals of the procedure

(1) Explanation of op amp theory and applications

(2) States goals
Circuit schematics

- Neatly drawn circuit with components, values, and units labeled.
- Connections of the components must be precise
- Supplies, sources, and ground should be annotated

Example 1 - Good

- Resistor values stated
- Voltage source (Vac0) included
- Units are clear

Example 2 - Excellent

- Source impedance clearly marked
Example 3 - Excellent

- Physical IC's with pins identified
- Breadboard connections mentioned

(1) Breadboard connections

(2) IC pins annotated
**Procedure**

- Clearly describe in a step by step fashion the procedure used for the experiment. Another student should be able to perform the experiment from your procedure.

- Remember that you will be allowed to use only your notebook not your lab manual when doing the experiment.

**Example 1 - Inadequate**

- No detail captured in the steps below
- Input of what varies?
- Why change the supply Voltage?
- Units not stated

1. Few steps captured in detail.
2. Misses on the units too
Example 2 - Excellent

- GBP theory mentioned in brief
- Student’s action to find GBP is stated
- Component values are clearly mentioned to achieve the results

(1) A detailed step by step procedure

Procedure and Theory:
In this part of the lab we are measuring the Gain Bandwidth Product (GBP) of the circuit from Part 2 (Figure 3). The GBP of an amplifier is the product of the amplifiers bandwidth and the gain from which the bandwidth is measured. This should be constant for all frequencies. To find the GBP of the circuit we measured the $f_{3db}$ at the desired gains (1, 5, 20, and 40). In order to do this, we changed the values of $R_f$ and $R_{in}$ to create the desired gains. We used $R_f = R_{in} = 1k$ (for the gain of 1), $R_f = 10k$ and $R_{in} = 2k$ (for the gain of 5), $R_f = 20k$ and $R_{in} = 1k$ (for the gain of 20), and $R_f = 100k$ and $R_{in} = 2.5k$ (for the gain of 40). In order to measure the output, we hooked up the oscilloscope to the Vout of the circuit and measured the voltage from peak to peak. The data that we collected is in Figure 4.

(2) The components and connection details helps!
Recording data

- Must be in a neatly organized table with units of measurements.
- Clearly annotated, labelled and linearised graphs with coordinates stated; for better visualization of the recorded data.

Example 1 - Excellent

- Sometimes oscilloscope screen shots like these are very helpful in recording data
- Recording data in correct table with the units and annotation

![Graph example](image1)

![Table example](image2)

![Oscilloscope screen shot](image3)
Example 2 - Inadequate

- No Units

A lot of scribbling and unclear, mistakes are ok, but start again fresh below!
Example 3 - Inadequate

The good:
- The student tried ;)

The bad:
- Nearly impossible to read
- No title
- No label
- No descriptive text

No vertical axis labels for a
Calculations
- List the relevant formulas and units for the calculations. Show all calculations clearly with attention to units.
- At least one sample calculation needs to be reported if that calculation is used repeatedly in the analysis of the data.

Example 1 - Excellent
- Lists relevant formulas
- Units clearly stated
- Stepwise simplifications stated

Clean step wise calculations with relevant formulas

The gain is roughly 14.5 V/V for different resistive loads.

Calculations:
- \( R_1 = 14.7 \, k\Omega \)
- \( R_2 = 1 \, k\Omega \)
- \( R_s = 5.1 \, k\Omega \)
- \( R_L = 10 \, k\Omega \)

- \( R_i' = \frac{R_i' + R_s}{R_i' + R_s} \)
- \( R_i = 6036.31 \, \Omega \)
- \( R_0 = \frac{R_{i'} - R_2}{R_L} = \frac{(5.1k)(10k)}{(5k + 10k)} = 0.015.94 \, \Omega \)
- \( A_{B} = 10.5 (1/15) = 0.667 \, \Omega \)
- \( R_{i'f} = R_i' (1 + A) = (6036.31)(1 + 0.067) = 40.24 \, MOS \)
- \( R_{Of} = \frac{R_o}{1 + A} = \frac{0.015.94}{0.067} = 0.9 \, \Omega \)
- \( V_f = \frac{V_0}{1 + A} \)
- \( B = \frac{V_f}{R} \frac{R_e}{R_1 + R_2} \)
- \( A_f = \frac{1}{B} = \frac{R_1 + R_2}{R_2} = 15 \) (used to design \( R_1 \), \( R_2 \))
Example 2 - Good

- Cases where a formula needs to be derived, essential for the further calculations
Results/Conclusion

- In a brief paragraph, clearly summarize what, if any conclusions you were able to draw from the result of this logical section.

- Discuss the major sources of error? How did these errors affect your results? How could the experiment be improved?

- The conclusion should relate directly to the purpose or goals of the overall experiment. Use your data to support/substantiate your conclusion.

Example 1 - Inadequate

- One liner
- No results discussed
- No comparison to the hypothesis
- No discussion of error
Example 2 - Excellent

- Hypothesis compared to the results
- Source of error was discussed

**Conclusion:**

As seen in the data above the output of the opamp is:

\[ V_{out} = 5 \times V_{in} \text{ where } -V_{dc} \leq V_{out} \leq +V_{dc} \]

This is what we expected to happen and what we wanted to happen. This shows that the Vout of the opamp is linear until it hits its limit at +/-Vdc. For \( V_{dc} = 15\text{V} \) we found that clipping happened after a \( V_{in} \) of 5V. For \( V_{dc} = 10\text{V} \) we found that clipping happened after \( V_{in} = 3\text{V} \). For \( V_{dc} = 5\text{V} \) we found that clipping happened after \( V_{in} = 1\text{V} \). What happened in this part of the lab was expected and proved our hypothesis correct.

**Best part:** compared the results with the hypothesis.
Lab Notebook Grading Guidelines

TA - Training

Sachin Ajit Devamare, WEC RA
David Orser, WEC Liaison
Agenda

• Introduce WEC Program
• Review Resources
  • Lab Notebook grading overview
  • Lab Notebook rubric
  • Example document for the students
• Summary and Links
WEC Program

• Expand upon Writing Intensive Course Requirements (WI)
• Define
  • Structure and consistency
• Provide resources
  • Grading student writing
  • Teaching students to write
What is a lab Notebook?

- A lab notebook is a foremost documentation for researchers
- Lab notebook will be used by the researchers to document journals, hypothesis, and interpretation of experiments

Alexander Graham Bell’s Lab Notebook
The Case of Gordon Gould

- Gordon Gould was the Inventor of LASER.
- Townes Advices for obtaining a Patent as an assistant.
- 30 Years of legal proceedings to claim the IP.

(Source: http://www.electronicdesign.com/components/gordon-gould-long-battle-laser-patent)
The audience

Target Audience: YOURSELF !!

• Refer or Compare the findings of an experiment in the future
• A rough and first document of your research
To be more specific,

- Diary format
- Organized chronologically
- Exhaustive
Overview

- Start Date
- Title
- Purpose of the Lab Experiment
- Break in to Logical Sections
  - Introduction
    - Schematics and Underlying Theory
  - Procedure
    - Details of steps (recorded data)
    - Calculations
  - Results
    - Interpretation
    - Error Analysis
Each Logical Section of the Lab Experiment

- **Introduction**
  - State purpose of the section
  - Draw Schematic for setup
  - Explain Underlying theory

- **Procedure**
  - Recording the behavior
  - Procedure steps

- **Results**
  - Discussing findings
  - Verify the hypothesis
Each Logical Section of the Lab Experiment

Introduction
- State purpose of the section
- Draw Schematic for setup
- Explain Underlying theory

Procedure
- Recording the behavior
- Procedure steps

Results
- Discussing findings
- Verify the hypothesis

“What are you going to do?”
Background/Textbook Info
Plan (Schematic)
Each Logical Section of the Lab Experiment

<table>
<thead>
<tr>
<th>Introduction</th>
</tr>
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<tbody>
<tr>
<td>1. State purpose of the section</td>
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<table>
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<tbody>
<tr>
<td>Recording the behavior</td>
</tr>
<tr>
<td>Procedure steps</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discussing findings</td>
</tr>
<tr>
<td>Verify the hypothesis</td>
</tr>
</tbody>
</table>

“How did you achieve the results?”

Visualize your recorded data
Each Logical Section of the Lab Experiment

**Introduction**
- State purpose of the section
- Draw Schematic for setup
- Explain Underlying theory

**Procedure**
- Recording the behavior
- Procedure steps

**Results**
- Discussing findings
- Verify the hypothesis

Show your “Key” results.

“What does your result mean?”

“Did it achieve the Goal? If not why?”
Contents

1. Introduction
2. Procedure
3. Results
What is the purpose of writing Introduction?

- State objectives and background theory
- Communicate the experimental setup
INTRODUCTION – COMMON MISTAKES

• Failing to mention the purpose of the lab report

• No theory relating to the experiment being discussed

• Failing to mention expected results
EXAMPLES OF INTRODUCTION CONSIDERED EXCELLENT

Outlines the Purpose

Discusses the underlying theory of the experiment

The expected result of the lab experiment is clearly mentioned!

Procedure and Theory:
In this part we built a new circuit – an inverting amplifier. This an opamp with a resistor tying the input and output of the opamp together creating feedback and a closed loop. This type of amplifier is more useful because it has a smaller gain that is more stable than an open loop gain opamp. We wanted to find out what the linearity and dynamic range of the output as a function of the op amp supply voltages for a sine wave signal at 1kHz.
SCHEMATIC – Intermediate and Excellent

INTERMEDIATE

EXCELLENT

Units Unspecified

No Label for the Fig

Units Specified

Source freq shown
A PROCEDURE SHOULD..

1. Clearly communicate the complete/Stepwise experimental setup
2. Record the experiment data, Visualize it in the form of charts and plots
3. Show the “important” calculations done.

Let us look at an example..
EXAMPLE OF THE PROCEDURE CONSIDERED – INADEQUATE

- No Steps described
- Why changing the supply voltage?
- Units not found!
Restating the theory is not a bad practice.

Procedure and Theory:

In this part of the lab we are measuring the Gain Bandwidth Product (GBP) of the circuit from Part 2 (Figure 3). The GBP of an amplifier is the product of the amplifiers bandwidth and the gain from which the bandwidth is measured. This should be constant for all frequencies. To find the GBP of the circuit we measured the $f_{3db}$ at the desired gains (1, 5, 20, and 40). In order to do this, we changed the values of $R_f$ and $R_{in}$ to create the desired gains. We used $R_f = R_{in} = 1k$ (for the gain of 1), $R_f = 10k$ and $R_{in} = 2k$ (for the gain of 5), $R_f = 20k$ and $R_{in} = 1k$ (for the gain of 20), and $R_f = 100k$ and $R_{in} = 2.5k$ (for the gain of 40). In order to measure the output, we hooked up the oscilloscope to the Vout of the circuit and measured the voltage gain peak to peak. The data that we collected is in Figure 4.

Steps involved in recording discussed.

Stepwise details of the experiment carried is listed with relevant component values.
SCHEMATIC – Intermediate and Excellent

INTERMEDIATE

- Axis Unspecified
- No Label for the Fig

EXCELLENT

- Axis labelling specified
- Figure Label specified

Graph showing Voltage Out (Volts peak to peak) vs. Voltage In (Volts peak to peak) with labels: VDC = ±5V, ±10V
HOW TO SHAPE THE RESULTS?

- All conclusions drawn from results should be clearly stated and supported with evidence.
- Key results and observations from the experiment should be quoted.
- Finally, it should recommend ways to correct problems and improve the experiment for more accurate results.

Your conclusion should essentially:

1. Summarize the important findings
2. Compare the result with hypothesis
3. Discuss the sources of error
RESULTS – COMMON MISTAKES

• Failing to summarize the Important findings
• Result data comparison being vague or not substantiated
• Sources of error is either not point out or isn’t validated.
• Failing to compensate the source of error.

Source of error is assumed

The impact of error on results not calculated
In this example,
- Findings are clearly stated with explanations
- Hypothesis agreement is highlighted
- Clearly states the results that were accomplished in this experiment

**Example of Good Conclusion**

**Conclusion:**
As seen in the data above the output of the opamp is:

\[ V_{out} = 5 \times V_{in} \text{ where } -V_{dc} \leq V_{out} \leq +V_{dc} \]

This is what we expected to happen and what we wanted to happen. This shows that the Vout of the opamp is linear until it hits its limit at +/-Vdc. For Vdc = 15V we found that clipping happened after a Vin of 5V. For Vdc = 10V we found that clipping happened after Vin = 3V. For Vdc = 5V we found that clipping happened after Vin = 1V. What happened in this part of the lab was expected and made our hypothesis correct.
ECE Lab Notebook Documentation:
• Overview – 1-page summary
• Rubric – Detailed description
• Examples – Commented student work

EE2xxx → EE3101 → EE3102

https://drive.google.com/drive/folders/0B8SwiYa7q5gLQTdvMLNCS2NtTkU
Einstein – Theory of relativity Notebook
Agenda

• Introduce WEC Program
• Review Resources
  • Lab report grading overview
  • Lab report rubric
  • Example document for the students
• Summary and Links
What makes a good Lab Notebook?

• Success - Effectively captures your actions
  – Organizes information logically
  – Written for YOUR reference in the future
  – Uses visual elements as well as words
  – Simple explanation for the data gathered

• It fails otherwise!!
Why?

• Industry
  – 3M E-Laboratory reports
  – Broadcom - Power Point Presentations

• Patent applications
  – Defends your claims, with data
  – Legal Document

• Academia
  – Acts as a reference
  – Re-do in future

“Industry managers have told me that our graduates are great with the technical, hard stuff but when it comes to promoting people; they are promoting people who are less skilled but can write and communicate better.” - ECE Faculty Member
The audience

Target Audience: YOURSELF !!

- Refer or Compare the findings of an experiment in the future
- A rough and first document of your research
To be more specific,

- Diary format
- Organized chronologically
- Exhaustive
The Snapshot

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"What are you going to do?"
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- Verify the hypothesis

“How did you achieve the results?”
Visualize your recorded data
Each Logical Section of the Lab Experiment

**Introduction**
- State purpose of the section
- Draw Schematic for setup
- Explain Underlying theory

**Procedure**
Recording the behavior
Procedure steps

**Results**
Discussing findings
Verify the hypothesis

**Show your “Key” results.**
“What does your result mean?”
“Did it achieve the Goal? If not why?”
## Comparison:

<table>
<thead>
<tr>
<th>Lab Report</th>
<th>Lab Notebook</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprises of four Important sections:</td>
<td>Chronological record, organized into logical</td>
</tr>
<tr>
<td>Abstract</td>
<td>sections:</td>
</tr>
<tr>
<td>Introduction</td>
<td>Introduction</td>
</tr>
<tr>
<td>Body</td>
<td>Procedure</td>
</tr>
<tr>
<td>Conclusion</td>
<td>Results</td>
</tr>
<tr>
<td>Audience: Peers, Researches etc.</td>
<td>Audience: Yourself</td>
</tr>
</tbody>
</table>

**Audience:**
- Lab Report: Peers, Researches etc.
- Lab Notebook: Yourself
AN EXAMPLE:
INTRODUCTION – COMMON MISTAKES

• Failing to mention the purpose of the lab report

• No theory relating to the experiment being discussed

• Failing to mention expected results

No Purpose
No background info
EXAMPLES OF INTRODUCTION CONSIDERED EXCELLENT

Outlines the Purpose

Discusses the underlying theory of the experiment

The expected result of the lab experiment is clearly mentioned!
SCHEMATIC – Intermediate and Excellent

INTERMEDIATE

Units Unspecified

No Label for the Fig

EXCELLENT

Units Specified

Source freq shown
ECE Lab Notebook Documentation:

- Overview – 1-page summary
- Rubric – Detailed description
- Examples – Commented student work

EE2xxx → EE3101 → EE3102

https://drive.google.com/drive/folders/0B8SwiYa7q5gLQTdvMlNCS2NtTkU
This could be YOU!!
Get inspired!
A lab report fully documents the experiment performed, the results, and their importance. In addition, a lab report should clarify the results by reviewing relevant background theory. Lab reports in ECE are designed to mimic reports done by practicing engineers. Examples of these would include an academic journal article, an internal company documentation report, or a public white paper.

The report should be written for an audience of peer engineers. Engineers which are familiar with the subject matter, but, not the specifics. Based on the report, they should be able to reproduce the experiment and perform their own analysis, such that they could either verify or dispute your conclusions.

Reports generally have four goals:
1. Allow others to quickly access the results (abstract)
2. Justify the reasons for conducting the experiment (introduction)
3. Record the results of the experiment (body)
4. Record your findings and reasoning (conclusion)

Think of this structure as telling a story: start by introducing the concepts, then logically layout the process of the experiment, and finally tell the audience what was found.

The report should generally be broken down into the following sections:

1) Abstract:
   a. Brief statement of purpose of the experiment
   b. Summarizes important findings
2) Introduction:
   a. Summarize contents of report
   b. Explain underlying theory or literature
3) Body:
   a. Describe experimental setup
   b. Step by step procedure
   c. Report measurements taken with calculated results
   d. Identify sources of error or noise
4) Conclusion:
   a. Restate important findings
   b. State the experiment outcome
   c. Compare to theory and discuss key errors

General Organization and Formatting
a. References, Citations
b. Neatness, Formatting, Grammar
c. Charts/figures/plots/diagram
d. Title page, date, name

After reviewing this document, please see the grading Rubric and the Examples of student work documents.
This grading rubric is part of the Lab Notebook Guidelines. Please read the Overview document first, then review this document, and finally read the Examples of student work document.

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Inadequate</th>
<th>Good</th>
<th>Excellent (in addition to Good)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brief statement of purpose of the experiment</td>
<td>No purpose stated</td>
<td>The specified purpose of the work lacks clarity, and is missing key objectives of the experiment.</td>
<td>States the purpose of the work, including objectives and/or hypothesis. (and states the overall direction of the experiment)</td>
</tr>
<tr>
<td>Summarizes important findings</td>
<td>Few or no major findings are reported</td>
<td>Findings are concisely reported (1-3 sentences)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Findings are discussed in extraneous detail</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Introduction

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Inadequate</th>
<th>Good</th>
<th>Excellent (in addition to Good)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summarize contents of report (Motivation) &amp; Direction</td>
<td>Few parts of the overall experimental objectives present</td>
<td>Some important steps/objectives may be missing</td>
<td>Summarizes important objectives, hypotheses, and steps. Author connects the purpose (in abstract) to the steps</td>
</tr>
<tr>
<td>Summarize relevant literature</td>
<td>No adequate details about the underlying theory mentioned</td>
<td>Briefly describes theoretical background necessary</td>
<td>Re-formulates theory specific to this physical implementation Derives formulas that are unique to this application (If required) Addresses concepts that impact method or measurements</td>
</tr>
</tbody>
</table>
## Procedure/Body

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Inadequate</th>
<th>Good</th>
<th>Excellent (in addition to Good)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental setup</td>
<td>No objectives listed. No discussion of experimental assumptions.</td>
<td>Briefly stated objective and assumptions.</td>
<td>Experiment specific formulas are derived</td>
</tr>
<tr>
<td>Experiment Schematic</td>
<td>Schematics not present/ incomplete</td>
<td>Schematics present with values of components and no label</td>
<td>Schematic with value and correct labelling. Also, contains additional parasitics and details relevant to the experiment.</td>
</tr>
<tr>
<td>Procedure</td>
<td>Simply a copy of lab manual</td>
<td>The experimental steps are correct.</td>
<td>The experimental steps are detailed with explanation for technical data gathered.</td>
</tr>
<tr>
<td>Measurements taken</td>
<td>Insufficient measurements to support claims made in abstract/conclusion.</td>
<td>Measurements taken are recorded in the form of tables for different cases with relevant calculations. The claims made in abstract are addressed and visualised with plots.</td>
<td></td>
</tr>
<tr>
<td>Sources of error or noise.</td>
<td>Missing sources of errors</td>
<td>Some source of errors are identified. The deviations if any are quantified.</td>
<td>All the sources of errors are identified. Recommendations to eliminate the errors are mentioned</td>
</tr>
</tbody>
</table>
## Conclusion

<table>
<thead>
<tr>
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<th>Good</th>
<th>Excellent (in addition to Good)</th>
</tr>
</thead>
<tbody>
<tr>
<td>State important findings</td>
<td>Key findings are missing or irrelevant</td>
<td>Key findings of the experiment are detailed</td>
<td></td>
</tr>
<tr>
<td>What is accomplished?</td>
<td>Does not state the accomplishment. Missing data.</td>
<td>States the results that were accomplished or not in this experiment</td>
<td>Gives a brief descriptions on why the approach was/wasn’t successful. Also, states inaccuracies if any.</td>
</tr>
<tr>
<td>Compare the result with hypothesis</td>
<td>The results were not compared to the hypothesis</td>
<td>Detailed analysis of the divergences or conformity of the results to the hypothesis with key sources of errors addressed.</td>
<td></td>
</tr>
</tbody>
</table>

## Miscellaneous

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Expectation</th>
</tr>
</thead>
<tbody>
<tr>
<td>References</td>
<td>References at the end of the report. Use textbook as a reference. If citing any particular work use IEEE citation standards unless otherwise directed <a href="http://www.ieee.org/documents/ieeecitationref.pdf">IEEE citation standards</a></td>
</tr>
<tr>
<td>Neatness, Formatting, Grammar.</td>
<td>The entire report should be typed This includes the title page, all parts of the report, and any references to figures. Maintain proper flow, for example, a table and graph should directly follow the paragraph that pertains to that part of the experiment.</td>
</tr>
<tr>
<td>Graphs/Plots</td>
<td>All graphs should have a title, axis labels (with per division labels), and a legend. Furthermore, the graph should be discussed in text (i.e. “In Figure 2, you can see the position data fits the line with a slope of 9.8m/s^2”).</td>
</tr>
</tbody>
</table>
ECE: Lab Report Guidelines

WEC

Examples of Student Work with Comments
This “Examples” handout (like the Rubric and Overview) is organized into: Abstract, Introduction, Body, and Conclusions. In each section, you will find examples of Inadequate, Good, and Excellent previous student work with comments from TAs and Professors.

Abstract

The purpose of writing abstract is to allow the readers to access whether it would serve his/her purpose to read the entire lab report.

The purpose of writing the abstract is to:

- Brief statement of purpose of the experiment
- Summary of important results

Example 1: Inadequate

- Purpose of the experiments is not discussed
- Experimental techniques followed are not clearly stated
- No major finding are reported

Operational amplifiers, including the 741 amplifier, exhibit non-ideal behavior in some configurations. Filter circuits with operational amplifiers have frequency responses, which may depend on the impedance of a feedback loop within the filter circuit. The filter circuits include low pass filters and bandpass filters.
Example 2: Good

- The purpose of the experiment is clearly stated.

Abstract:
The goal of this experiment was to characterize several different Operational Amplifier. Using a wave function generator and an oscilloscope the amplitude transfer functions and characteristics were studied for inverted amplifiers, low pass active filters, and band pass active filters. This is an important study because unlike passive filter systems operational amplifiers can amplify the signal with a negative feedback resistor network.
Example 3: Excellent

- The purpose of the experiment is stated.
- Important experimental techniques are outlined.
- The findings from the experiments are stated.

This experiment investigated some of the realistic operating behaviors of the 741 op amp compared to idealized models, focusing especially on dynamic range and frequency response characteristics. The op amp was then implemented in a series of active filter circuits to again study how closely the circuits behave compared to theoretical calculations. Though the op amp did not exhibit the characteristics of an ideal op amp, many of the theoretical models provided a reasonable approximation of the actual circuits' behavior. This was an important investigation because it revealed how reliable these theoretical models are for predicting real-world behavior.
Introduction

Introduction gives the reader the objectives and the purpose of the experiment. With the specific background information/literature.

- Summarize contents of report and give an overview of the experiment
- Summarize relevant literature
- Explain underlying theory

Example 1: Inadequate

- No literature or theory relating to the experiment are discussed
- No attempt made to give a brief outline

<table>
<thead>
<tr>
<th>Experiment outline in setup portion incomprehensible</th>
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| Underlying theory not mentioned |
Example 2 : Excellent

- Places parts into logical groups and discusses the purpose of those groups
- Underlying theory specifically mentioned
Body/Procedure

A good procedure must contain the approach followed to arrive at the result, justifying the purpose of the experiment. With detailed experimental setup and the experimental results.

- Contains detailed Experimental setup
- The step by step procedure followed
- Details of the recorded measurements with the calculations

Example 1 : Inadequate

- Experimental steps followed are not described
- Calculations not shown
Example 2: Excellent

- Brief objective with schematic
- Detailed step-wise procedure
- Important formulas and measurements with graphs

3. Experiments
Open loop gain of the 741 Op-Amp

1. This experiment consisted of deriving and measuring the low frequency, open loop gain of the 741 op amp. The configuration of the circuit to analyze is shown below in Figure 1.

Figure 1. The configuration of the circuit in order to determine the open loop gain of the 741 op amp.

Experimental Setup: To measure the gain of the circuit we first setup a variable resistor between the two offset ports and tuned the resistor until the output just switched from the high rail to the low rail. The circuit was setup according to the values and configuration of Figure 1 and the op amp was powered with +15 V and -15 V voltage source. The input was created using a function generator providing a 5 Hz sinusoidal wave and the output was measured using an oscilloscope.

Calculations:
The calculation for the open loop DC gain is provided for us from the manual.

\[ A_p = \frac{V_{out}}{V_{in}} \times 10,000 \]

Results:
The experimental results measured when the 5 Hz signal was used as the input to the system.

\[ V_{out} = 11.4 \text{mV} \text{ and } V_{in} = 46 \text{mV} \]

From this we can determine the DC open loop gain.

\[ A_p = \frac{11.4 \text{mV}}{11.4 \text{mV} - 46 \text{mV}} \times 10,000 = 50.294 \]
Conclusion

Conclusion should emphasize on interpretation of the data, relating them to existing theory and knowledge. Appreciable if suggestions are made to improve on the experimental techniques. Most important aspect is to report the error or the deviation from the hypothesis, with reasons.

- Summarize the important findings
- Compare the result with hypothesis
- Discuss the sources of error

Example 1: Inadequate

- Important result data not summarized.
- Sources of error not discussed

---

**Conclusion**

In this experiment a handful of op-amp circuit configurations were tested to determine characteristics about the op-amp being used as well as the circuit itself. Using the theoretical equations associated with device parameters the values measured could be compared to their expected theoretical values. The open loop gain, bandwidth, GBWP, and slew rate were determined experimentally. The last three experiments found that circuits 5 and 6 were first and second order active low-pass filters respectively due to their roll offs. The circuit for experiment 7 was determined to be an active band-pass filter with a mid-band unity gain. From these experiments it shows how many uses the op-amp has and that it can easily implement a variety of useful functionalities.
Example 2: Good

- Key findings of the experiment are presented and supported by specific data
- States the important findings along with relevant data
- Source of error is not explicitly stated, however divergence shown
Lab Report Grading Guidelines

TA Training

Sachin Ajit Devamare, WEC RA
David Orser, WEC Liaison

University of Minnesota
Agenda

• Introduce WEC Program
• Review Resources
  • Lab report grading overview
  • Lab report rubric
  • Example document for the students
• Summary and Links
WEC Program

• Expand upon Writing Intensive Course Requirements (WI)
• Define
  • Structure and consistency
• Provide resources
  • Grading student writing
  • Teaching students to write
What makes a good report?

• The report exists to provide the reader with useful information
• It succeeds if it effectively communicates the information to the intended audience
• It fails otherwise!!
The audience

Target Audience: Technical Engineers (non-specialist)

Often 3 different types

• Casual reader (Abstract)

• Result oriented reader (Abstract and Conclusion)

• A specialist peer (Body)
Overview of a Report

Abstract
Brief description of the experiment with summary of findings

Introduction
Emphasis on the background information necessary to understand the hypothesis tested in the experiment

Procedure
The steps you took to test the hypothesis

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Discussion/Conclusions
Based on the Introduction, did the Procedure produce the expected results? Discuss the actual results.
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**Summary**

Summarizes the experimental objective (“what you did”) – tells results and its significance.
# Overview of a Report

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Presents the Background knowledge necessary for the reader to understand the hypothesis better
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Allows an outsider to verify the results, data and calculations.
Overview of a Report

- **Abstract**: Brief description of the experiment with summary of findings

- **Introduction**: Emphasis on the background information necessary to understand the hypothesis tested in the experiment

- **Procedure**: The steps you took to test the hypothesis

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**Analyse and interpret how well the hypothesis was supported with any deviations.**
Contents

1. Abstract
2. Introduction
3. Body
4. Conclusion
How a Lab Report Overview look like

1) Abstract:
   a. Brief statement of purpose of the experiment
   b. Basic idea about the experiment
   c. Summarizes important findings

2) Introduction:
   a. Summarize contents of report
   b. Explain underlying theory or literature

3) Body:
   a. Describe experimental setup
   b. Step by step procedure
   c. Report measurements taken with calculated results
   d. Identify sources of error or noise

4) Conclusion:
   a. Restate important findings
   b. State the experiment outcome
   c. Compare to theory and discuss key errors

5) Miscellaneous
   a. References, Citations
   b. Neatness, Formatting, Grammar
   c. Graphs/Plots
What should an abstract look like?

- The abstract should contain one or two paragraphs which clearly and concisely present an overview of the report.
- Complete sentences must be used, not phrases.
- It should be clear, concise, to-the-point.

An Abstract should give..

1. The Basic idea about the experiment and what you did.
2. Summary of important results.

University of Minnesota Driven to Discover
ABSTRACT – COMMONLY MADE MISTAKES

1. Purpose not discussed.
2. Experimental techniques not stated
3. No major finding reported
4. Too wordy (3-5 sentences are ideal)

Example of an inadequate abstract

Operational amplifiers, including the 741 amplifier, exhibit non-ideal behavior in some configurations. Filter circuits with operational amplifiers have frequency responses, which may depend on the impedance of a feedback loop within the filter circuit. The filter circuits include low pass filters and bandpass filters.

Purpose of experiment is not pointed out
Findings are not discussed
What is the purpose of writing Introduction?

- To convey the purpose of doing this experiment and its objective.
- Familiarize the reader with the necessary background information and give an outline of the rest of the report.

An should necessarily..
INTRODUCTION – COMMON MISTAKES

- Failing to summarize important contents of the report.
- Inadequate or no theory relating to the experiment being discussed.
- Failing to clearly portray the previous work being done in that particular area.
- Not outlining the rest of the paper.

The purpose of this lab was to measure the frequency response of several amplifying and filtering circuits. For each circuit, the response to a range of input frequencies was measured in terms of gain and/or phase. The experiments will be outlined with a setup and measurements portion. The setup portion of each experiment will contain theoretical values of what the experimental outcome should look like.

A brief outline could have been given in the introduction if at all the contents are summarized in the later parts.
This experiment was carried out in seven parts. The first four parts investigated specific characteristics of the op amp including open-loop voltage gain, the dependence of dynamic range and bandwidth on supply voltage and gain, respectively, and slew rate. The final three parts explored the frequency-dependent characteristics of three filter circuits that include the 741 op amp.

An operational amplifier is a DC coupled high gain voltage amp with differential inputs, and a single output. They are used in a variety of different products for a vast range of uses, and are among the most widely used electronic devices today. The particular op amp used in this lab was the 741 chip. The main use of the 741 chip is to amplify weak signals. There are two ways to use this op amp, either as an inverting amplifier, or as an amplifier. An inverting amplifier changes the polarity of the input, and outputs the reversed signal. A non-inverting leaves the polarity of the input the same as the output. These two options will be seen throughout the lab. The schematic of the chip is given below:

Figure 1: 741 Op Amp Chip Diagram
A BODY SHOULD..

1. Clearly communicate the complete experimental setup
2. Give a step by step discussion of the procedure
3. Clearly report all the necessary measurements collected
4. Mention the sources of error or noise.

Let us look at some of the examples..
Structure of Body in Report

Objectives
Identify the main objective(s) of the experiment
Should be in one brief paragraph

Methods and Procedures
- Strategy used to obtain the data
- Explaining the experimental setup
- Describing the procedural steps in much detail

Discussion of Results
- Present all the relevant observations made
- Prepare graphs and tables to best display them
- Indicate and analyze significant difference expected results
- Be as specific and quantitative as possible
EXAMPLE OF THE BODY CONSIDERED – **INADEQUATE**

**Set Up:**

![Circuit Diagram](image)

**Figure 4. Circuit for part 3**

**Table 3: f_{3dB} and GBWP for part 3**

<table>
<thead>
<tr>
<th>R1, R2 (Ω)</th>
<th>Av(V/V)</th>
<th>Vn(V)</th>
<th>Vg(V)</th>
<th>f_{3dB}(Hz)</th>
<th>GBWP (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10k-10k</td>
<td>1</td>
<td>1</td>
<td>0.707</td>
<td>390,000</td>
<td>390,000</td>
</tr>
<tr>
<td>2k-10k</td>
<td>5</td>
<td>1</td>
<td>3.333</td>
<td>71,000</td>
<td>355,000</td>
</tr>
<tr>
<td>1k-20k</td>
<td>20</td>
<td>0.025</td>
<td>0.601</td>
<td>40,000</td>
<td>980,000</td>
</tr>
<tr>
<td>2.3k-160k</td>
<td>40</td>
<td>0.025</td>
<td>1.14</td>
<td>40,000</td>
<td>15,000,000</td>
</tr>
</tbody>
</table>

**Conclusion:**

- **No Steps described**
- **Directly measures data without calculations**

---

**OOPS!**
HOW TO STRUCTURE THE CONCLUSION?

- Summarize the important findings
- Compare the results with the hypothesis
- Discuss the sources of error

All conclusions drawn from results should be clearly stated and supported with evidence. Specific results and observations from the experiment should be cited. Finally, it should recommend ways to correct problems and improve the experiment for more accurate results.

Your conclusion should essentially be accurate. The linearity and dynamic range of the 741 chip was observed with varying supply voltages to the positive and negative supply terminals on the chip. It was found that the amplifier could not produce an output voltage higher than the differential voltage supplied to its positive and negative DC terminals. The gain-bandwidth product was also determined to be 459,600V/Hz/V. The slew rate of the specific chip was also experimentally determined with square and sine wave input signals. The average slew rate for the square wave was 1.354 V/us.

Circuits were constructed using op amps and the frequency response characteristics were measured and compared with theory. Data found in lab agreed with theoretical values within a reasonable error percentage, with error coming from measurement rounding and instrument noise.

Source of error is indicated

Key findings clearly stated
CONCLUSION – COMMON MISTAKES

• Failing to summarize the Important findings
• Result data comparison being vague or not substantiated
• Sources of error is either not point out or isn’t validated.
• Failing to compensate the source of error.
EXAMPLE OF GOOD CONCLUSION

In this example,
• Findings are clearly stated with explanations
• Divergence of result values from the hypnosis is highlighted
• Clearly states the results that were accomplished in this experiment
ECE Lab Report Documentation:
• Overview – 1-page summary
• Rubric – Detailed description
• Examples – Commented student work

EE2xxx → EE3101 → EE3102 → EE 4951W

https://drive.google.com/drive/u/0/folders/0B8SwiYa7q5gLSHhTelhfdzQyYWM
Lab Report Grading Guidelines
Pre-Lab Lecture

Sachin Ajit Devamare, WEC RA
David Orser, WEC Liaison

University of Minnesota
Agenda

• Introduction to Report writing
• Structure of Report writing
• Discuss an example
• Review Resources – Lab Report
  • Overview
  • Rubric
  • Example
• Summary and Links
What makes a good report?

- Succeeds if it effectively communicates information to the intended audience
  - Organizes information logically
  - Written for a targeted audience
  - Uses visual elements as well as words
  - Backs up statements with data
  - Accounts for error

- It fails otherwise!!

Quotes from VP/Directors/Managers:
- “The more professional your writing, the more you are trusted.”
- “I have many examples of when poorly written communications created a lot of pain and blocked productivity.”
The audience

Target Audience: Technical Engineers (non specialist)

Often 3 different types

• Casual reader (Abstract)

• Result oriented reader (Abstract and Conclusion)

• A specialist peer (Body)
Why?

• Industry
  – MISO - MTEP Report
  – Broadcom - Power Point Presentations

• Academia
  – IEEE Journal/Conference Styles
  – Thesis Format

• Tell a Story
  – Tell ‘em what you’re going to tell them
  – Tell ‘em
  – Tell ‘em what you told them.

"Industry managers have told me that our graduates are great with the technical, hard stuff but when it comes to promoting people; they are promoting people who are less skilled but can write and communicate better.”
- ECE Faculty Member
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Summarizes the experimental objective (“what you did”) – tells results and its significance
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**Presents the Background knowledge for the reader to understand the hypothesis better**
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Allows an outsider to verify the results, data and calculations
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- Record data, but also emphasize data with **visualizations**.
## Overview of a Report

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**Analyze and interpret how well the hypothesis was supported, account for error sources**
An Example: Abstract & Introduction

• Both Abstract and Introduction
  – Beginning of the report
  – Prepare the reader for further reading

<table>
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<td>States purpose</td>
<td>Explains importance / Draws in the reader</td>
</tr>
<tr>
<td>Lists results</td>
<td>Reviews background</td>
</tr>
<tr>
<td>SHORT!</td>
<td>Explains methods</td>
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ABSTRACT – COMMONLY MADE MISTAKES

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Figure 1: 741 Op Amp Chip Diagram
ECE Lab Report Documentation:

• Overview – 1-page summary
• Rubric – Detailed description
• Examples – Commented student work

EE2xxx → EE3101 → EE3102 → EE 4951W

https://drive.google.com/drive/u/0/folders/0B8SwiYa7q5gLShH6hLhfQzQyYWM
We often think of computer programs as a set of instructions that tell the computer what we want it to do. However, many programs also have a second purpose: to tell other programmers what we want the program to do. Therefore, it is important that programmers write code that is readable and understandable for other programmers.

Programmers who share a style can communicate more efficiently. The particulars of the style are less important than the understanding that comes with utilizing a shared style. Therefore no rule in this document is absolute and you should defer to your instructor for the final word on style choices.

That said, there are a number of different principles and guidelines for writing readable code. A comprehensive discussion of good coding style can take an entire website or textbook. The purpose of this document is to provide a short guide with examples of important coding style practices.

**Overview of guidelines:**

1. Use informative comments.
2. Use descriptive names with unique styles to differentiate variables, constants, classes, etc.
3. Use whitespace to emphasize the functionality of the code.
4. Use classes and/or functions to make complicated code more understandable.

**Explanation of guidelines:**

1. Use Informative comments.
   Within each section of a program there should be descriptive comment that outlines the purpose and function of the section. The beginning of the program should identify what it is the reader is viewing. Each function should be described and have its inputs and outputs defined. Each group of variables should have descriptive text, where needed to identify the purpose of those variables. Oftentimes code will self-comment, utilize this to make your program less lengthy.

   a. Author Block - At the beginning of the program the owner of the code must identify themselves with a small description. For example:

   ```
   Name:
   Student ID number:
   Course number:
   Term:
   Lab/assignment number:
   Date:
   ```

   b. Local variable description
   List all the local variables used by the functions. What they are used for? Provide any other relevant information (like units!)
   ```
   double spdInMphr; // Speed in Miles per Hour
   ```
c. Function Header - At the beginning of each major function, briefly describe the purpose of function.

```cpp
// Function: square_the_smallest
// ---------------------------
// Returns the square of the smallest of its two input values
// n1: one real value
// n2: the other real value
// returns: the square of the larger of n1 and n2
double square_the_smallest(float n1, float n2) { ...... }
```

d. Avoiding comments that merely repeat what lines of codes do.

```cpp
// Input a
Cin >> a ;
```

2. Use descriptive names
Variable, class, and function names should be short and self-explanatory. Use stylistic choices to differentiate the types.

a. Variables, Functions, and Classes, etc. should have names that describe their purpose.

```cpp
a = b / c ;                     // Is less informative
Speed = Distance / Time ;      // Makes code more Informative and readable
```

b. Naming conventions to differentiate variables, constants, classes etc.
Using this might be very helpful for the reader to distinguish, variables, Constants, and CLASSES.
The rules are not universal, however, it is a good practice to follow some differentiative naming conventions:

<table>
<thead>
<tr>
<th>Variable</th>
<th>speedOfVehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>speed_Of_Truck</td>
</tr>
<tr>
<td>Classes</td>
<td>SPEED</td>
</tr>
</tbody>
</table>

```cpp
```

c. Use named constants instead of “magic numbers”.
Any values that are constant throughout the program should be declared using the #define directive. Using this directive makes the program easier to understand than simply using the constant value it-self multiples times in the program, and it makes it easy to change the value throughout the program at some later time.

Instead of 3.1416 or 1.5708 in your program, please refer to it as PI or PI_by_2.

d. In addition, one should not go overboard and write the complete description as a variable name like,

```cpp
Int speedOfTheTruckInMilesPerHour;
```
e. Avoid unneeded Variables.
   It is easy to create confusing code with too many intermediate variables, as shown in the example below:

   ```
   // Adding two numbers and display result - Avoid
   cin>>a; cin>>b; temp=a; temp1=b; result=temp+temp1;
   cout<<"Result is "<<result;

   // Adding two numbers and display result - Better Way
   cin>>a; cin>>b;
   cout<<"Result is "<<a+b;
   ```

   Temporary variables should only be used if results are used in multiple calculations or to make longer calculations more meaningful.

3. Use vertical and horizontal whitespace to make the meaning of the code clear.

   Use white space (i.e., spaces, tabs, carriage returns) generously to emphasize the structure of your program and to make it easy to read. Make sure you indent and align statements, comments, loops, and nested structures appropriately. Generally, use one space before and after the equal signs (=), relational operators, and parentheses, and comment delimiters. For example:

   ```
   newSalary = (1 + raise) * currentSalary; // calculate new salary
   ```

   It is a good practise to indent statements inside control structures (i.e., the code in flower brackets shown below.) The example below is known as Kernighan and Ritchie style\(^1\).

   ```
   if (hours < 24 && minutes < 60 && seconds < 60){
     return true;
   }else{
     return false;
   }
   ```

4. Use functions and/or classes to make the complicated code more understandable.

   Classes and functions are useful for a variety of reasons. The most important reason is **reusability**. Once a function is defined, it can be used over and over and over again. If a given piece of code is written more than once in your program it should probably be embedded in a function. Using functions reduces errors, makes bug fixes propagate throughout your code, and saves you work when writing the code.

   Another reason is **abstraction**. Having a simple external interface for a complicated piece of code makes it easier for other programmers to reuse your work. In order to use a function, you only need to know its name, inputs, outputs, and where it lives. You don’t need to know how it works, or what other code it’s dependent upon to use it (for example standard libraries.)

   For these reasons and many others, use of functions and/or classes will make your code more understandable, easier to write, and easier to debug.

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\(^1\) [https://en.wikipedia.org/wiki/Indentation_style#K&R](https://en.wikipedia.org/wiki/Indentation_style#K&R)
## VI. WEC Writing Plan Requests

**Unit Name:** Electrical and Computer Engineering

### Financial Requests (requests cannot include faculty salary support) **drop-down choices will appear when cell next to “semester” is selected**

**Total Financial Request:** $23,340.00

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<th>Qty</th>
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<th>Qty</th>
<th>Service</th>
<th>Qty</th>
<th>Service</th>
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<td>LnL ($15pp)</td>
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<td>LnL ($15pp)</td>
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<td>4 Smaller Meetings ($10pp)</td>
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<td>4 Smaller Meetings ($10pp)</td>
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<td>TA Seminar Refreshments ($8pp)</td>
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**Semester 1 Total:** $10,885.00

**Semester 2 Total:** $785.00

**Semester 3 Total:** $10,885.00

**Semester 4 Total:** $785.00

### Description and rationale for services

Food is the most efficient method to generate good will and good attendance. The RA will facilitate, document, and co-lead portions of the implementation activities.

### Service Requests **drop-down choices will appear when a cell in the “service” column is selected**

| Service | Qty | Service | Qty | Service | Qty | Service | Qty | Service | Qty | Service | Qty | Service | Qty | Service | Qty | Service | Qty | Service | Qty | Service | Qty | Service |
|---------|-----|---------|-----|---------|-----|---------|-----|---------|-----|---------|-----|---------|-----|---------|-----|---------|-----|---------|-----|---------|-----|---------|-----|---------|
| Consultation | 1 | Consultation |     |         |     |         |     |         |     |         |     |         |     |         |     |         |     |         |     |         |     |         |
| Seminar   | 1   | Seminar   |     |         |     |         |     |         |     |         |     |         |     |         |     |         |     |         |     |         |     |         |
| Other     | 1   | Other     |     |         |     |         |     |         |     |         |     |         |     |         |     |         |     |         |     |         |     |         |

**Description and rationale for services**

Food is the most efficient method to generate good will and good attendance. The RA will facilitate, document, and co-lead portions of the implementation activities.
August 1, 2018

To: David Orser  
From: Robert McMaster, Office of Undergraduate Education  
Subject: Decision regarding WEC plan and funding proposal

The Department of Electrical and Computer Engineering recently requested the following funding to support its Writing Enriched Curriculum:

<p>| | | |</p>
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<tr>
<td>Fall 2018</td>
<td>Research assistant</td>
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<tr>
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</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>$ 23,340.00</strong></td>
</tr>
</tbody>
</table>

All requested items have been approved by the Office of Undergraduate Education for a total of $23,340.00.

Please email Lori Smith (lsmith@umn.edu) and Heidi Solomonson (heidis@umn.edu) within 30 days of the receipt of this letter with the EFS account string in your department that will receive these funds. $11,670.00 will be transferred during FY19 and $11,670.00 will be transferred in FY20.

CC: Dan Emery, Pamela Flash, Matt Luskey, Bryan Mosher, Jennifer Peterson, Jennifer Reckner, Rachel Rodrigue, Leslie Schiff, Lori Smith, Heidi Solomonson