Laboratory 1 – Engineering Reporting
Assigned Week of September 19, 2011
Due Week of September 26 2011

I — Introduction:

Besides having good technical skills and being experts in their field, all engineers must demonstrate outstanding communication skills which are essential for presenting results of their work. Any engineering work is not of much value unless it is communicated clearly and concisely. If you can't make the case, no matter how good the science and technology may be, you're not going to see your ideas realized.

The formal medium for written communication is the "engineering report". Because the engineering report is so important (both in the learning process and in practice), it is one of the first educational requirements on your road to becoming a qualified and competent professional. While the format is likely to vary slightly from course to course (and in practice), all engineering reports have the same basic structure. That structure is introduced and applied in this laboratory. Once the basic structure is mastered, reporting becomes a relatively easy exercise – "second nature", so to speak.

*All ECOR 1010 laboratory submissions are to be **formal**, according to the following format:*

Title Page: In formal reports a title page identifies the title of the report, the person or affiliation to whom the report is intended (in your case this is your Teaching Assistant), the author (in your case this is your name and student number), and date. You should note that the date is critical in engineering reporting for many reasons. For instance, establishing a potential patent may depend on the date of an engineering report. An example of the format expected for the title page of ECOR 1010 reports is presented on page 6 of this laboratory.

Table of Contents, List of Figures, and List of Tables: Generally, these are all included in professional engineering reports, however, *you may omit them in your laboratory submissions (but not in your project)* because your reports will be relatively short.

Introduction: The introduction section provides the reader with the background necessary to understand the report and provides 'context' for the reader. It begins with a brief overview of what the laboratory was about, and then follows with the reason(s) for doing the work and for submitting the report.

Of special importance is a clear concise statement of the objective(s) at the end of the introduction. Note that even if you may feel that the objective for doing one or another ECOR 1010 laboratory is that it is required to pass the course, this does not introduce the reader to the engineering exercise at hand and therefore such an objective is not relevant. The objective(s) must focus on the technical work in the exercise.

It is also worth mentioning that personal pronouns should generally not be used in technical reports. You should write "The experiment was done . . . " instead of "I did the experiment . . . ".

Method: This section details the steps (procedure) used to fulfill the *objective* stated in the introduction. Describe how the objective was investigated. If you develop a clear, concise statement for the purpose of the laboratory and keep this clearly in mind while detailing the method, then writing this section should be easier to do.

Results and Discussion: In this section, the results of your work are presented followed by a discussion of your assessment of what the results mean. It is important that this section be written in a clear and concise fashion. Tables, graphs, and drawings are often included to support the discussion. Make sure to explain to the reader the importance of the tables and graphs with some words in the text; simply including graphs and tables without explaining why they are there is not done. References can be made to the Appendix (see description below) in which detailed calculations are presented. In addition, only the results relevant to the *objective* are to be included. Interesting results and experiences that may have appeared in the laboratory but are not related to the objective are to be included as part of the Appendix. The point is that the report must be focused on the *objective* at all times.

Any difficulties or anomalies encountered in the investigation are included in the discussion after the results have been presented. The significance of the findings is also included in this section.

Conclusions: This brief section lists the specific conclusions arrived at on the basis of the work described in the report. Conclusions are to be significant and pertinent. State whether the *objective* was achieved. Often the conclusions are two or three bulleted or numbered statements, but a short paragraph format is also acceptable.

References and Acknowledgements: References and acknowledgements are contained in long engineering reports. They *will not be necessary* in your ECOR 1010 write-ups, including the project, again because you are being asked for very brief reports.

Appendices: Sketches, drawings, tables, calculations and graphs should be attached to the report as *appendices*. Note that each appendix must contain text to indicate clearly the relevance of the content to the report.

Engineering reports generally are no longer than absolutely necessary. In this course, the entire length of a report (excluding the Title Page and Appendices) is limited to **ONE PAGE (12 point font size with at least one inch (2.5 cm) margins all around).**

The software tools used to write engineering reporting generally consist of the following:

- Word processing (e.g., Word) – all students are assumed to have word processing skills;
- Table setting (e.g., Word or Excel) – all students are assumed to have spreadsheet skills;
- Graphing (e.g., Word or Excel);
- Equation setting (e.g., Equation Editor) – to be used in this laboratory;
- Sketching software (e.g., IntelliCAD) – software sketching is not expected in Laboratory 1. This will be the focus of Laboratory 2.

II — Problem Statement:

The fundamental goal of engineering is to ensure our technology is safe for the public to use: safety of the public is the first priority for all engineering. Safety can have an immediate effect: buildings and bridges have to stay standing, electrical devices cannot electrocute people, water must be free of harmful substances, and nuclear reactors must operate in a controlled way. Safety is also important in the long term. More and more, engineers are being asked to design and build things with a longer term regard for safety. Engineers are being asked to limit the harm our generation does to the environment so that future generations can enjoy the same world we enjoy today. In this context, engineers are finding ways to minimize our energy consumption and reduce greenhouse gas production, which are two problems that are generally believed to pose a threat to future societies. There are no simple solutions, and often balances are found between competing factors. In this lab you are asked to prepare a brief formal report comparing the energy consumed to manufacture and operate aluminum-bodied cars and steel-bodied cars. Cars with aluminum bodies are lighter and therefore more fuel/energy efficient to operate. However, aluminum is more expensive to produce than steel, so aluminum cars take more energy to manufacture. Currently, most car bodies are made from steel.

When the term 'aluminum' or 'steel' body is used it means the 'body-in-white' (BIW) structure shown in Figure 1. Searching various references, libraries and manufacturer's reports you gather the data listed in Table 1.

Figure 1. Body-in-white structure for a mid-sized car.

Table 1: Data for Car with Aluminum or Steel Body-in-White

Characteristic	Aluminum	Steel
Mass of Body-in-White	135.0 kg	225.0 kg
Mass of Aluminum and Steel Used to Manufacture Body-in-White	270.0 kg	450.0 kg
Energy Required to Produce Aluminum and Steel	201.0 MJ/kg	30.00 MJ/kg
Fraction of the Energy Required to Produce Aluminum and Steel from Recycled Material	5.000%	33.00%
Recovery Rate of Aluminum and Steel from Scrapped Cars	90.0%	95.0%
Total Finished Mass of Car	1270 kg	1360 kg

You also find the following data:

- The average lifetime distance travelled by a car with a steel BIW is 283 000 km.
- The chemical energy in 1 litre of gasoline is 32.20 MJ. In practice, this amount of energy cannot be converted to useful work (i.e., moving the car) by burning gasoline in an internal combustion engine because some of the energy is lost to heat. An indication of the efficiency of conversion is given by the fuel consumption for a distance travelled, which usually has units of L/100 km. The fuel consumption can be estimated with the aid of equation 20.10 for the fuel efficiency given in the textbook:

$$\text{fuel efficiency [km/L]} = -6.95 \times 10^{-3} \times \text{mass of car [kg]} + 19.87$$

- The energy needed to refine the gasoline and deliver it to a gas station is 5.10 MJ/L.
- 270.0 kg of aluminum are needed for the process to manufacture the aluminum BIW, which has a final mass of 135.0 kg. The leftover 'process' scrap metal is recycled into more BIW structures. For the case of steel, 450.0 kg are used to manufacture the BIW, which has a mass of 225.0 kg, and the process scrap metal is likewise recycled into more BIW structures.

To compare the total energy consumed by both the aluminum and steel structured vehicles you will graph the difference in the energy consumed versus the distance driven over the life of the cars. This will be done twice: the first time will be for a BIW manufactured from new material, and process scrap, and the second time for a BIW manufactured from recovered scrapped vehicles, and process scrap.

NOTES:
- Pay attention to the number of significant figures and make sure to use quantities exactly as provided.
- All data are real and have been taken from reliable sources.

III — Steps and Calculations:

For both an aluminum and steel body-in-white, complete the following steps.

1. Use the data provided to determine the energy needed to manufacture the BIW out of aluminum and out of steel. Notice that twice as much mass of material is needed to produce a BIW than the mass of the final BIW; the half of the material that does not become a BIW is called ‘process scrap’ and is recycled. Assume that each BIW is produced from 50.0 % recycled ‘process’ scrap metal.

2. Use the data provided to determine the energy needed to drive one kilometre in each of the vehicles.

3. Plot the difference in the total energies consumed for the aluminum and steel bodies-in-white (*i.e.*, total energy for aluminum BIW minus total energy for steel BIW on the vertical axis) as a function of distance driven, from zero to 300 000 km, on the horizontal axis. At what distance travelled do the two vehicles consume the same total energy?

4. Calculate the percentage change in the energy consumed by using the aluminum BIW compared with the steel BIW for the average vehicle lifetime distance of 283 000 km (i.e., the energy difference relative to steel).

5. After the working lives of the vehicles are over, the bodies-in-white are recovered from the scrapped vehicles at the rates indicated in Table 1. If this recovered material is re-manufactured into second-generation BIW vehicle structures, calculate the energy requirement for this re-manufacturing process for both steel and aluminum vehicles. (Assume that new metal is used for the balance of the material used in the re-manufacturing process, which is as described in step 1 above.)

6. Make another plot of energy difference on the vertical axis and distance travelled on the horizontal axis, as in step 3, but this time for the second generation vehicles with the aluminum and steel bodies-in-white produced with the manufacturing process of step 5. At what distance travelled do the aluminum and steel second-generation vehicles consume the same energy?

7. Calculate the percentage change in the energy consumed by using the aluminum BIW instead of the steel BIW after the average vehicle lifetime distance (283 000 km) for the second-generation vehicles (i.e., the energy difference relative to steel).

8. Estimate the energy cost savings for both the first and the second generation vehicles in terms of today’s cost of gasoline (assume 1.30 $/L).

9. Construct and complete a table summarizing your results for each of the steps 1 to 7 similar to the one that follows. Pay attention to significant figures and units.

Step No.			
1	Energy to Manufacture Body-in-white	Al:	Steel:
2	Energy to drive one kilometre	Al:	Steel:
3	Distance where the two vehicles have consumed the same energy		
4	% increase or decrease for the aluminum vehicle relative to the steel vehicle after 283 000 km		
5	Energy to re-manufacture the second generation BIW with recovered material	Al:	Steel:
6	Distance where the two second-generation vehicles have consumed the same energy		
7	% increase or decrease for the 2nd generation aluminum vehicle relative to the 2nd generation steel vehicle after 283 000 km		
8	Energy Cost Savings for 1st and 2nd generation vehicles	1st:	2nd:

IV — Report Requirements:

- Using a word processor, write a formal engineering report of your findings and submit it to your lab section's Teaching Assistant (whom you should treat as your boss). The report must be compiled according to the ECOR 1010 format discussed earlier. You should include in the Appendix (or Appendices):
  - your sample calculations – these can be done by hand, written as engineers' notes (neatly and in ink);
  - 1 table produced as a result of Step 9 of Section III ("Steps and Calculations");
  - 2 graphs/sketches as a result of Steps 3 and 6 of Section III.

- In the "Results and Discussion" section of your report, among other things, you should:
  - Mention the significance of the results obtained in Steps 1, 3 and 6 of Section III;
  - Present a brief qualitative and quantitative comparison of aluminum versus steel body-in-white.
  - Conclude which of the structures consume less energy.
  - Which structure would you recommend? Why?
  - Briefly evaluate the validity and accuracy of the results in the light of the assumptions;
  - Avoid leaving any important data in the Appendix(ces) unmentioned and unsupported in the body of the discussion.

- <u>Don't forget that the written text of the report must be no longer than one page</u>. Additional materials are to be included as appendix pages — sketches, figures and tables, etc. Remember that the figures and tables must be properly labelled and supported with text in the results and discussion, as described above.

V — Submission and Timing:

Your report is to be submitted to the Teaching Assistant within the first 30 minutes of your next laboratory period (week of September 27–October 1, 2009). **LATE SUBMISSIONS WILL NOT BE ACCEPTED.**

VI — Marking:

Laboratory submissions will be marked on a 10-point scale: 9-10 (excellent); 7-8 (good); 5-6 (marginal); less than 5 (fail). Be sure that you are familiar with the University's policy on plagiarism and academic integrity: generally, it is wrong to present work done by another person as your work. Your instructors are obligated to report all suspected violations to the Associate Dean of Engineering for investigation.

VII – ECOR 1010 Title Page Template:

ECOR 1010 – Introduction to Engineering

Laboratory #1

Engineering Reporting

To:
TA Name: Ms. Good Ta
Email: goodta@connect.carleton.ca
Lab Section: A3
Room: 3129ME – Carleton University

From:
Student Name: Stu Denteng
Student Number: 100######
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Date: September ??, 2011