Laboratory Record-Keeping

A good laboratory notebook is a must for those engaged in any analysis and design work. Such a notebook provides the engineer with an accurate record of all that occurs during the course a project. Good record-keeping helps track down errors, act as a reminder of analysis or design methods undertaken during the project, and (as one's career progresses) provides accurate records to substantiate patents, copyrights, and other intellectual property documents.

A large (≈ 8.5" × 11") bound notebook, such as the National 43-648 Engineering Computation Notebook , with paper that withstands occasional erasures should be used. Coarse (≈ ¼") cross-ruled pages are perferred since they are useful for entering sketches, and tabular and crude graphical data. Everything that is committed to paper should be put in the notebook, including hardcopy of computer anaysis (tape or glue the print outs in the notebook). Avoid notes on loose pages: such scraps of paper are often lost. Avoid erasures whenever reasonable: correction of errors should always be done by crossing them out (what seems to be an error at first may not actually be an error). Write only on the right hand facing pages of an open notebook: the left pages are for afterthoughts and exploratory calculations and may be used in place of scratch paper.

Guidelines for a good laboratory notebook

Heading of the experiment

Copy the laboratory number and the name of the experiment to the laboratory notebook. Write down the date of the experiment, the name of each member of your group, and the equipment used (serial numbers is best, although the lab station number is adequate).

Original data in the notebook

The notebook is a record of all relevent designs, observations, hypotheses, and analyses that occured during the course of the experiment: **`the work should be reproducible soley from the notebook`**. Careful descriptions of the procedure and the experimental "set-up", in the engineer's own words, are essential. "Diagrammatic" sketches are often preferrable to "pictorial" sketches. Original data must be recorded directly into the notebook as it is acquired. If errors are later found or if calibration measurements are used to correct data, these revised readings should also be recorded without deleting the original data. If multiple readings are taken and then averaged, record all of the data as well as the average value. The data should be arranged in tabular form when appropriate and each item or table should be properly labeled. Initial and date the the lower right hand corner of the right hand facing page.

Housekeeping deletions

A notebook combining all work might become a mess, with a proliferation of erroneous and superseded material. Matters can be improved greatly with a little housekeeping work every hour or so. Just draw a box around any erroneous or unnecessary material and hatch three or

four lines across this box. This way the deleted material can be used in the future if the first idea was correct after all. Append a note to the margin of the box with an explanation of the error.

Notes are expected to be kept current, from minute to minute, as the laboratory work progresses. While formal reports will be assigned, this notebook is the primary record of the laboratory work.

Remarks and sketches

As stated previously, diagrammatic sketches are often the simplest and clearest wayh to define the various quantities indicated in a data table: **a phrase or sentence introducing each table or calculation is essential for making sense out of the notebook record**. Whena useful result occurs at any stage, it should be described with at least a word or phrase. At the end of an experiment, some sort of written comment, usually including a brief summary table of results, is needed.

Graphs

Hand-drawn graphs or computer output may be attached into the notebook with glue or transparent adhesive tape. Original data in graphic form should also be fastened directly into the notebook. The graphs must be properly labeled with a descriptive title in an unused portion of the graph. Appropriate scales must be indicated. Graphs must have abscissas and ordinates which wlaways require labeling. **Data should never be diretly plotted on a graph without first entering the data in an accompanying data table**.

Data and results

A neat summary of data and results will make the notebook more meaningful for both the experimenter and evaluator. Comparisons to theory or expectations are required. Reasons for variations from theory and expectations must also be given whenever possible. Comments and conclusions should accompany any summary.

Partners and the work ethic

Limitations on equipment and space often require that tow or more work together on a given experiment or project. Usually, a group of two produces an efficient work team in the instructional format. Additionally, it is often stimulating to be able to discuss the work as its progresses with a partner. **Each experimenter will perform completely independent calculations and keep a separate laboratory notebook.** Mistakes in calculations are inevitable: the more independent the calculations are between partners, the more complete is the check against mistakes. Poor results on experiments are often the result of computational errors.

Completion of work

Calculations, graphing, and miscellaneous discussions should be completed before leaving the laboratory. The laboratory instructor will check the laboratory notebook every day before the experimenter is excused. The laboratory wil be evaluated for a grade. Additionally written comments, suggestions, or questions will be entered by the instuctor. **The same**

laboratory notebook standards will be used for those laboratory experiments requiring formal reports.

Seek the help of the laboratory instructor to deepen understanding of the subject being inverstigated.

Formal Laboratory Reports

Engineers are often required to present experimental evidence to an outside evaluator. A formal report if often the medium for presentation.

A report should be written so that it can easily be followed by the reader. If should clearly convey the reasoning which led to the experimental method used and the particular results obtained. The technical level of the report should be such taht a peer can readily comprehend the results. Whidle the format for the report can vary, all reports usually contain the following information:

- Title of the experiment
- Purpose of the experiment
- Description of the experimental apparatus
- Identification of the experimenters
- Description of the experimental procedure
- Experimental results
  - Data summaries (tables, graphs, etc.)
  - Computations and analysis
- Comclusions and comparisons to theory and expectations
- Appendices with supporting material

It is particularly important to annotate the "Experimental results" section so that the reader can understand the significance of each table, graph, etc. Conclusions and comparisons to theory and expectations should be quantitative whenever possible. Variation expressed as a percentage usually carries greater significance than absolute variation. Reasons for the variations must also be given whenever possible.

Reports should be typed on one side of standard 8.5" $\times$ 11" paper. Computer outputs and other supporting matierial may be included in appendices. The report need not be lengthy or elaborate. However, it must be neat and well organized. Use good grammar and correct spelling.