TRIDENT TECHNICAL COLLEGE

innovation | education

Industrial and Engineering Technology Division
Student Handbook
For
Course and Laboratory Work

INTRODUCTION

Report generation is a fundamental part of engineering technology. Engineering technicians, as they proceed in school and industry, develop ideas, write programs, solve problems, and perform experiments and tests that must be documented. Engineering technicians must be able to produce concise, accurate, and readable reports that clearly explain what, where, when, why and how something was done, and which interpret the results.

Every corporation has its own format for technical reports. Therefore, the object of this booklet cannot be an attempt to teach all possible formats. Instead, representative report formats are presented that fit the needs of the technology programs at Trident Technical College.

USING THIS MANUAL

This manual is provided to help you complete your course work with the greatest understanding of the material. In addition, this manual describes the procedures and forms to be used for work submitted for grade in all Engineering Technology courses. These guidelines furnish detailed instructions for preparing student papers. Subjects covered are:

1 Homework.

2. Projects in which programs for computers, programmable controllers or automation are required.

3. Laboratory reports

    A. Memorandum
    B. Data Logbooks
    C. Oral
    D Formal

These laboratory report guidelines pertain to those exercises that focus on the investigation of particular principles and/or characteristics. They do NOT cover the results of laboratory exercises based on design, field work or special projects that may require results to be reflected in additional sections pertinent to the subject (e.g., electrical layout plans, survey field work, etc.).

Required formats will be specified in the course syllabus. General guidelines are:

1. The Memorandum Report will be the most frequent type of laboratory report. The exact number required will be specified by the instructor.

2. Formal reports will be limited in number so that each student can expect to submit no more than one such report per semester. Major grading emphasis will be placed on this report.

3. Check the appropriate section in this guide for required forms and procedures.

SECTION 1
COURSE HOMEWORK

GENERAL REQUIREMENTS:

1. Use only 8 ½ x 11 inch white unruled or Ampad 22-141 green problem paper.

2. Homework should be identified on the first page by date, student name, unit and problems assigned, course number with course section number, page number and total number of pages. See Figure 1-1 for an acceptable example.

01/11/01 Dwar Pharquar Unit 2 Chap 5 # 12, 13 Chap 6 # EGR 110-099 Page 1 of 3

Chapter 5

12. List the best rating actor for each performance factor

Performance Factor	Rating
Clock Rate	450Mhz
Word Size	64 Bit
Cache	512k
Instruction Set	RISC
Pipelining	Yes
Parallel Processing	Yes

Figure 1-1 Homework First Page Example

Dwar Pharquar	Page 3 of 3

Figure 1- 2 Homework Additional Page Example

3. Additional pages, if necessary, should be stapled, numbered using the page number format from the first page, and include the student's name. See figure 1-2 for an acceptable example

4. The problem statement should be summarized briefly preceding the answer or solution.

ESSAY QUESTIONS:

1. All answers should be complete sentences and should contain a reference to the question.

2. Answers will be graded for spelling, grammar, sentence structure, clarity, completeness of communications and technical competence. Professional standards for written work will be stressed.

3 Answers may be in script, lettered, typed, or, preferably computer generated using a word processing program (e.g. Word 97). If script is used, it must be legible.

4 Acceptable example is shown in Figure 1-1.

NUMERICAL PROBLEMS:

1. Use Ampad 22-141 green problem paper, which is available in the bookstore.

2. All numerical problems should include the following information:

   A. A summary of the question or problem statement.
   B. When required, a sketch or diagram to describe pictorially the problem to be solved. Freehand sketches are permitted.
   C. A list of all known or given values.
   D. A list of all unknowns or statement describing what must be found or calculated.
   E. The step-by-step problem solution. Every step in the solution must be shown.
   F. The final answer, compete with proper units, should be clearly identified by underlining or enclosing it in a box.

3. An acceptable example is shown in Figure 1-3 .

REVIEW OF ARTICLES:

1. Give the title, author, date, pages and publisher of the article.

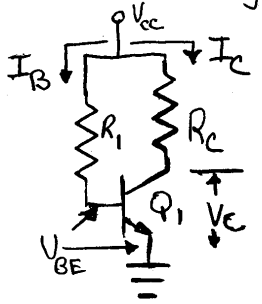
2. Present a description of the problem or a summary of the major and minor topics addressed by the author.

3. Include a discussion of the major points of the article that apply to the problem or topic.

4. Conclude with a summary that describes the relationship of the major points introduced in the article to the problem or topics addressed.

1/11/01 Dwar Pharquar | Unit 2 Prob # 7,8,9 | EET-131-099 | 1/3

7 Select the required resistors to bias the following circuit Class A



Given: Beta = 100; $V_{cc} = 24V$

Q_1 (Silicon) $V_{BE} = .6V$

Find R_1 and R_C

a) $V_C = \frac{1}{2} V_{CC}$ (For Class A Operation)

$= \frac{1}{2} * 24V$

$= 12V$

b) $I_C = 2mA$ (Selected for Small Signal Conditions)

c) $R_C = \frac{V_{cc} - V_C}{I_C}$

$= \frac{24V - 12V}{2mA} = 6000\Omega = 6K\Omega$

d) $I_B = \frac{I_C}{Beta}$

$= \frac{2mA}{100} = 0.02mA$

$R_C = 6K\Omega$

$R_B = 1.17M\Omega$

e) $R_B = \frac{U_{CC} - U_{BE}}{I_B}$

$= \frac{24V - .6V}{.02mA}$

$= 1\,170\,000\Omega = 1.17M\Omega$

Figure 1-3 Sample Problem

SECTION 2

COMPUTER and PROGRAMMABLE LOGIC CONTROLLER PROGRAMS

COMPUTER PROGRAM DOCUMENTATION:

1. The solution to programming problems should include the following items:

   A. The question or problem statement.
   B. A flowchart or a problem definition and algorithm that describes the solution in detail.
   C. A program listing with adequate comments consistent with the rules of structured programming, with particular emphasis on documentation, segmentation and style.
   E. The items are to be submitted to the instructor using Campus Cruiser.

2. Use 8 ½ X 11 paper for all typed or handwritten material.

PROGRAMMABLE LOGIC CONTROLLER PROGRAM DOCUMENTATION:

1. The solution to programmable controller problems should include the following items:

   A. The question or problem statement.
   B. Ladder logic diagram.
   C. Input and output connection references.
   D. Program Logic statement when available

2. Use 8 ½ x 11 paper for all typed or handwritten material.

SECTION 3

LABORATORY REPORTS

ENGINEERING TECHNOLOGY MEMORANDUM REPORTS

GUIDELINES:

The purpose of memorandum reports is to demonstrate to the instructor how well you understand basic laws and how they apply to the experiment that you performed.

OUTLINE:

Seven parts of a memo report are listed in Figure 3-1. Because of variations in course requirements, not all parts will be required in every report. The first part should be included on the memo cover page (Figure 3-2). Part two comprises the body of the report and is placed on a page following the cover page. Third part is the appendices, this should follow on a separate page following the main body of the memo report.

Figure 3-1, MEMORANDUM REPORT OUTLINE

1. Cover Page
   - A. Name of student
   - B Name of experiment and dates performed
   - C. Associates (names of other participants)
   - D. Date report submitted

2 Main Body
   - A. Objectives
   - B. Conclusions

3. Appendices
   - A. Procedures
   - B. Equipment and Supplies
   - C. Diagrams
   - D. Data Tables
   - E. Graphs and curves
   - F. Calculations
   - G. Questions

TRIDENT TECHNICAL COLLEGE
(Course Number) MEMO REPORT

TO: (Name of Instructor)

FROM: (Name of Student)

SUBJECT: (Number and Name of Experiment and Dates Performed)

ASSOCIATES: (Names of Other Participants)

DATE: (Date Report Submitted)

Figure 3-2 MEMORANDUM REPORT COVER SHEET

COVER PAGE

The following is what should be contained in each of the fields on the cover page of a memo report. See figure 3-2 for layout of cover of the page.

TITLE:
The course number should be included in the title at the top of the page.

NAME OF STUDENT:
The name of student submitting the report. No group reports are permitted, every student must submit a report.

SUBJECT:
The report is identified by the number (if applicable) and the name of the experiment and the dates performed.

.**ASSOCIATES:**
List the full names of all participants.

DATE REPORT SUBMITTED:
The date the report is submitted

MAIN BODY

Format

The Main Body should have 1" margins all around. The name of the lab and page number should be in a header on the right side of the page. See figure 3-3.

[Insert Experiment Name Here] Page#

Objectives:

Figure 3-3 Memorandum Report Main Body

OBJECTIVE(S)

Every experiment is performed for a reason.. You can use the objectives that accompany the lab. If there are no objectives listed with the lab briefly explain why the experiment was performed

EXAMPLE:

The objective of this experiment was to determine the discharge coefficient of a Venturi tube.

CONCLUSIONS:

The conclusion statement is the most important part of an experiment. It briefly details if data from the experiment validates the objectives that are being tested. Be specific and avoid empty statements such as, "I found the data to be pretty good.", or " Everything went well I learned a lot from this lab".

The conclusions should not include any lengthy theoretical discussions. This section of the report should not exceed two paragraphs at the very most. If the objectives includes the verification of some law or theorem, then the Conclusions should mention the verified material in your own words.

EXAMPLE:

For pipe with a Reynolds number above 105, the discharge coefficient of the venturi tube was 0.98. This value is within 5% of the value predicted by theory.

APPENDICES:

All supporting evidence for the conclusions should be included here.

FORMAT:

The Appendices should have 1" margins all around. The name of the lab and page number should be in a header on the right side of each page. See figure 3-4.

[Insert Experiment Name Here] Page#

APPENDICES

Procedures:

Equipment:

Diagrams:

Data Tables:

Sample Calculations:

Graphs:

Questions:

Figure 3-4 Memorandum Report Appendices

PROCEDURES:

Only deviations from the printed procedure are noted in this section. When there are no deviations, make the statement ***"No deviations from experiment instructions."***

EQUIPMENT:

Identify each particular piece of equipment used in the experiment. It is necessary to determine if anomalous results occurred due to an equipment malfunction. As a minimum, state the name of the equipment (e.g., a voltmeter) and a specific identifying feature such as the serial number or state identification number. If it is important to readily identify the equipment, include the manufacturer and model number. See Figure 3-5.

EQUIPMENT:
Regulated Power Supply, SN 0248
Oscilloscope, HP 122A, SN 175-0761A
Voltmeter, RCA WVIOI, SN 768195
Power Supply, HP 1407, SN 192-14786

Figure 3-5, EQUIPMENT IDENTIFICATION

DIAGRAMS:

A block or schematic diagram is usually supplied on the experiment explanation sheet in laboratory manuals; refer to it by page and figure number. If changes in the diagram are made or if the diagram is necessary to explain the data tables, include a correct diagram in the report.

DATA TABLES:

All observed and calculated data are tabulated (see Figure 3-6). All related data, whether observed or calculated, are included in a single table when possible. Eleven guidelines are listed below to assist in producing data tables.

1. Every table has a title.

B. Use a computer spreadsheet program (e.g. Excel) whenever possible to record and print data tables.

3. The independent variable appears in the first column.

4. Every column has a heading.

5 If a column is obtained from Calculations, the equations and a sample calculation must be included in the Sample Calculations section.

6. The paper may be turned ninety degrees clockwise to draw the table if necessary.

7. Decimal points are to be aligned vertically.

8 Explain each symbol used in a column heading. Give the dimensions or units of the symbols in a symbol key immediately below the table.

9 Any blank column position must be explained in a footnote.

10 Do not indicate repeated numbers with ditto marks, dashes or straight lines. Write out all numbers.

11. Leave at least one inch margins on all sides.

Figure 3-6 DATA TABLE

Motor Characteristics					
Torque lb. Ft	Speed RPM	Watts In	Hp In	Hp Out	Efficiency %
0.00	870.0	1043.0	1.4	0.0	0%
5.00	830.0	1790.0	2.4	0.8	33%
10.00	760.0	2460.0	3.3	1.4	44%
15.00	750.0	3060.0	4.1	2.1	52%
20.00	690.0	3650.0	4.9	2.6	54%
25.00	640.0	4330.0	5.8	3.0	52%
30.00	600.0	5000.0	6.7	3.4	51%
35.00	570.0	5660.0	7.6	3.8	50%
40.00	510.0	6490.0	8.7	3.9	45%
45.00	470.0	7460.0	10.0	4.0	40%
50.00	430.0	8730.0	11.7	4.1	35%

Torque Output in Lb-Ft	Measured
Speed in RPM	Measured
Input Power In Watts	Measured
Input Horsepower	Calculated
Output Horsepower	Calculated
System Efficiency	Calculated

SAMPLE CALCULATIONS:

At least one sample of each type of calculation is required in the report. Use a "meaningful" data set, i.e., avoid using zero. The sample calculations show the methodology used to obtain the displayed data. If errors are found, additional data can be taken. Define all terms and specify the units of all data used for the calculations. Additional calculations of the same type need not be put in the report. An example is shown in Figure 3-6.

Data taken at 30.0 lb ft Torque

$hp_{in} \propto W_{in}$

hp = Horsepower

W = Watts

$hp_{out} = T \times N$

T = Torque

N = Speed

$$\text{Efficiency} = \frac{P_{out}}{P_{in}}(100)$$

P = Power

$$hp_{in} = 5000\ \text{W}\left(\frac{1\ \text{Hp}}{764\ \text{W}}\right) = 6.7\ \text{hp}$$

$$hp_{out} = (30.0\ \text{lb. ft.})\left(\frac{600\ \text{rev.}}{1\ \text{min.}}\right)\left(\frac{2\pi\ \text{rads}}{1\ \text{rev.}}\right)\left(\frac{1\ \text{hp}}{3300\ \text{lb.ft/min.}}\right)$$

$$= 3.4\ \text{hp}$$

$$\text{Efficiency} = \frac{3.4\ \text{hp}}{6.7\ \text{hp}}(100) = 51\%$$

Figure 3-7 Sample calculations

GRAPHS

See Figure 3-8. Graphs may be drawn by hand or with a computer (as allowed by your instructor) using the graphing function of spreadsheet program (e.g. Excel 97) using the following guidelines.

1. Use 8 ½ x 11 graph paper/computer paper (as applied)

2. Draw all curves with black ink or pencil.

3. Place the graph title in the top center position of the graph.

4. The independent variable normally appears on the horizontal axis and the dependent variable on the vertical axis.

5. Label the ordinates and abscissa correctly with the proper units. An ordinate must always be on the left. Ordinates may also be on the right and multiple ordinates may be used.

6. Choose scales that are easy to read and that use most of the graph paper.

7. Letter or type all information on curves.

8. Do not write in the margins.

9. Draw all lines and curves with uniform thickness and darkness. Make the ordinate and abscissa slightly thicker than the curves.

10. Use a French curve or snake to draw all curves.

11. Place your name and the date in the lower right corner of the graph.

12. Curves may be drawn with the graph paper in either the vertical or horizontal position. If the paper is used in the horizontal position, it should be stapled into the report so that the reader can read it by rotating the report ninety degrees clockwise from the normal position. The ordinate must still be on the left.

13. When plotting a curve from an equation, do not show data points. Draw the curve with uniform thickness and darkness. State the equation of the curve on the graph.

14. When plotting data points from an experiment, show all points. Do not draw lines connecting the points. Draw an average smooth curve. Points should be large enough so they are not obscured by the curve. The curve need not pass through any of the points. If a curve fitting procedure is used, state the equation on the graph and identify the procedure used.

15. If more than one curve is drawn on the same set of axes, code the data points so they can be easily identified with a particular curve. The coding may be symbols such as: *2,* X and ∆ Circles should be drawn with a template and lines with a straight edge. The symbols should be small. Put a legend on the curve to identify the symbols with the associated curves or identify the curves as illustrated in Figure 3-7.

16. More than one ordinate may be used so that several curves can be superimposed. Each ordinate must have its own scale and description. When more than one ordinate is used, the curves must be identified with the proper ordinate. Letters may be used for identification.

17. When a family of curves is plotted, each curve must be identified with the value of the parameter that is being varied.

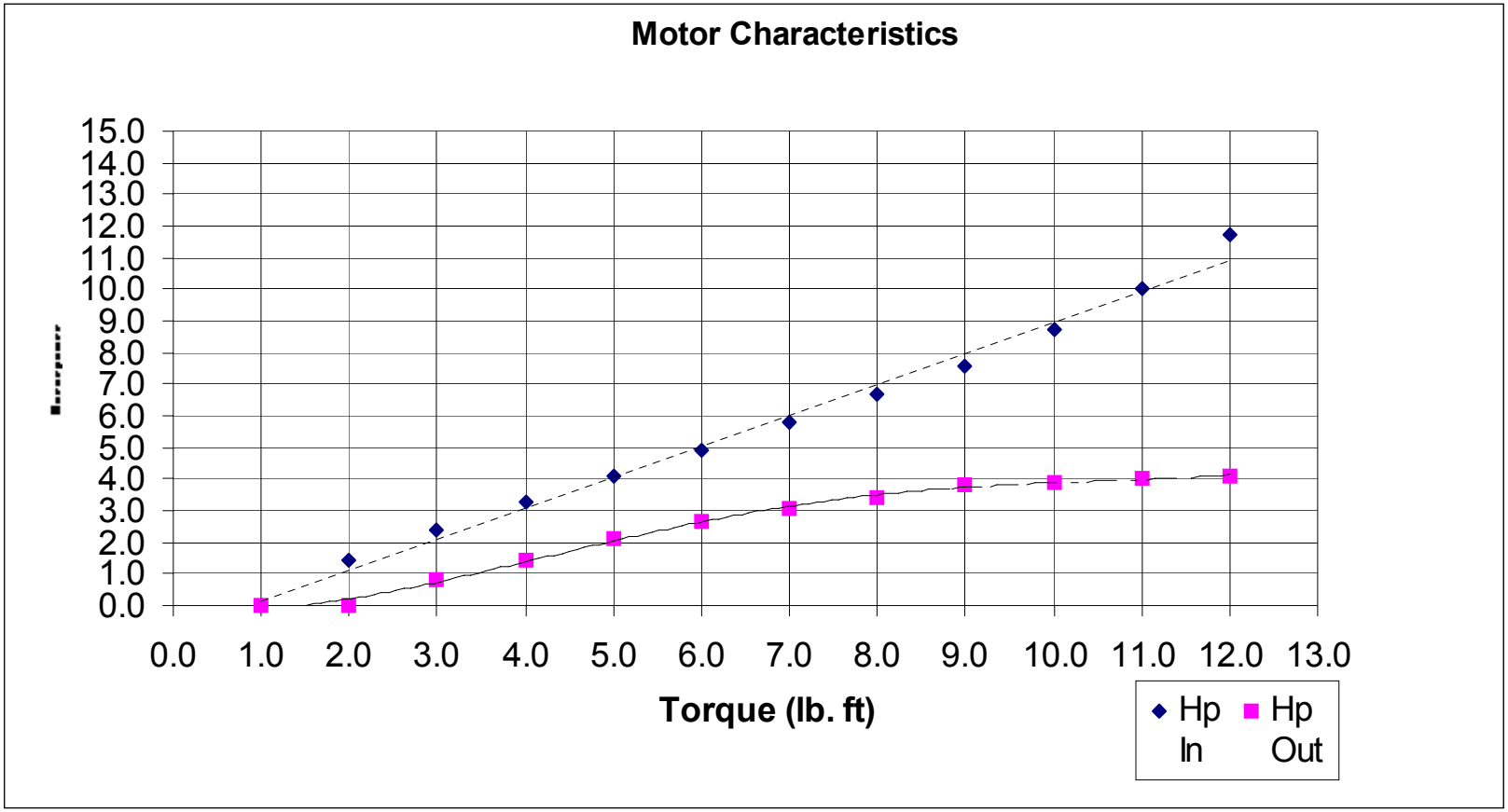


Figure 3-8 Example graph

QUESTIONS:
The questions assigned in the laboratory experiment are a valuable learning tool. They are designed to help you understand the principles involved in the experiment and to help you interpret your data.

GRADING:
See Figure 3-8. All memo reports may have a Laboratory Report Scoring Breakdown attached. The instructor will grade the report using the criteria listed in the breakdown sheet; however, the points assigned may vary among courses.

LABORATORY GRADE
ORAL FORMAL LOG BOOK MEMO

IMPROVEMENT NEEDED IN:

Neatness
- Text _____
- Drawings _____
- Graphs _____

Composition _____
Spelling _____
Grammar _____
Theory _____
Conclusions _____
Accuracy _____
Completeness _____
Log Book _____
Organization _____
Oral Delivery _____

COMMENT:

DATE:

GRADE:

Figure 3-9 LABORATORY REPORT SCORE SHEET

DATA LOGBOOKS AND LOGBOOK REPORTS

GUIDELINES:

The LOGBOOK has two uses in the laboratory. First, all experiment data are initially, recorded in the logbook during the experimental process. Second, in some courses the final report will be prepared in the logbook. The log book is intended to be a continuous record of your experimental work. You will get poor marks if you write your book outside the laboratory from results written on scraps of paper. A good log book will contain a great deal of **experimental comment** in addition to the results. It will also show clearly erroneous data that were corrected. The following entries are required in the logbook for every experiment:

1. Experiment title and date
2. Student name and names of other participants
3. Course name, number and section
4. Objectives of the experiment
5. Experimental equipment list and numbers
6. Schematics and drawings
7. Sample calculations
8. Data tables
9. Experimental observations
10. Signature

The following entries are also required for a logbook report:

1. Data results and graphs
2. Conclusions

LOGBOOK REQUIREMENTS:

Use the following guide when making entries in the logbook:

1. The logbook should be a "Computation Book" with bound and numbered pages such as the number 22-157 from American Pad and Paper Company.

2. Pages should never be removed.

3. Record all experimental results directly in the logbook.

4. Never erase information from the log. Use a single line to strike out any incorrect entry; record corrected data above it.

5. Always date the start of an entry and sign at the completion.

6. Use the logbook as an experimental diary.

7. Do not leave blank pages. Should you do so inadvertently, place a diagonal line across the page.

GRADING:

See Figure 3-9. Logbooks will use the same grading procedure as the memo reports.

ORAL REPORTS

GUIDELINES:

An oral report takes the form of a short class presentation or interview (no more than 15 minutes). You will be asked to present or discuss aspects of your laboratory work. The presentation/discussion might range from a "briefing to your instructor on a particular laboratory endeavor" to an "interview-discussion" involving presentation of your laboratory notebook. Your instructor will set the requirements. In any event, your grade will be based on a combination of "technical adequacy" and "presentation competence". Preparation for this task should minimally include:

1. Outline of the material in sequence of presentation.

2. Individual rehearsals.

3. Preparation of visual materials such as overhead projections (ask assistance of your instructor in this matter).

FORMAL REPORTS

GUIDELINES:

A formal report is written with the assumption that the reader is an engineer or technician not familiar with the specific work covered. The report must be complete and should be understood without previous knowledge of the test or experiment. A good report is thorough, orderly, neat, grammatically correct and "leads" the reader step-by-step through the experiment. Use the following guidelines in writing formal reports.

1. Use 8 ½ x 11 white unruled paper.

2. Double spaced typed or word processor produced text is required.

3. Leave at least one inch margins on all sides.

4. Use the three levels of section headings given in the following section.

5 Do not repeat instructions and procedures when writing the Results section; state results in terms of findings.

6. Avoid slang expressions.

7 Avoid empty statements like, "The experiment was quite accurate." Include real information, "The results of this experiment showed a variation of less than ± 15% from the expected value."

8 Write in the third person; past tense, active voice. Avoid passive phrases: It was found ...; It was seen ... ; It was thought ... ; etc. Instead use active language: The problem was ...; The [apparatus] measured ....

9. Make definite statements.

10. Make reports only as long as necessary; they are not graded by weight.

11 Number all important equations for easy identification and refer to them in the text.

12. Number all pages starting with the Introduction page.

13 In text, the word "percent" is spelled out. The % symbol may be used in charts, tables and graphs.

14 In text, spell out single digit numbers. Numbers of more than one digit may be written as numerals. In charts, graphs or tables, numerals should be used consistently.

15 Refer to all tables and graphs in the text of the report. Any table or graph that is without a reference, is not relevant and should be deleted.

16. Standard engineering abbreviations may be used in the text of the report.

17 If information is quoted from a book, place the statement in quotation marks, use single spacing, follow the quote by a parenthesis containing the last name of the author followed by a comma and the date of publication. State the author, title, publisher, edition, and pages in the Bibliography.

18 Equations, pages, and figures must be either numbered sequentially or may be identified by section number. Examples: equation seven in section one may be numbered (1-7), figure four in section three may be identified as Figure 3-4.

19 Identify all schematics, data tables, charts and graphs as "figures". Every figure must have a concise title.

SECTION HEADINGS:

See Figure 3-10. All sections and subsections must be identified by headings. The first level heading (number one heading) identifies the section; the second level heading identifies a major topic within a section; the third level heading identifies a topic subordinate to the second level section. The heading levels are easily identified when the report outline (table of contents) is produced. Do not use more than three levels of headings or indentures in the outline. Rule of thumb: A topic change means a new heading is needed.

OUTLINE:

See Figure 3-11. Each of the eleven sections of the formal report is distinct and separate. Therefore, each section title carries a number one heading (all capital letters, centered at the top of the page). Not all eleven sections are required for every report; requirements vary among courses.

SECTION HEADINGS

SECTION LEVEL	HEADING FORMAT
1	All capital letters, centered at top of page
2	All capital letters, underlined or bold
3	All capital letters

Figure 3-10 Section Headings

FORMAL REPORT OUTLINE

1. Title page.
2. Table of contents.
3. List of Illustrations.
4. Introduction.
5. Objectives.
6. Theory.
7. Procedures.
8. Results.
9. Analysis of Results
10. Recommendations.
11. Appendix.
12. Bibliography.

Figure 3-11 Formal Report Outline

TITLE PAGE:

See Figure 3-11. The title page serves as a cover for the report. The information on the title page is:

A. Name of Experiment or Report.

B. Course Identification.

Format: Course Name
Course Number

C. Technician's Identification.

Format: Name: (of individual preparing the report)
Associates: (names of other participants; place in parenthesis)
City, State: (where work was performed)
Dates: (the work was performed)
Date: (of submission)

The guiding principle for the title page is neatness. Place the name of the report three inches from the top of the page and centered. Center the course identification midway down the page and the technician's identification three inches from the bottom.

TABLE OF CONTENTS:

See Figure 3-12. The table of contents identifies the sections of the report by page number; it serves as the report outline. The pages that contain the TABLE OF CONTENTS and LIST OF ILLUSTRATIONS should be numbered i, ii etc.

LIST OF ILLUSTRATIONS:

See Figure 3-13. The list of illustrations identifies all diagrams, charts, tables, and graphs by page number, figure number and title.

INTRODUCTION:

The introduction gives a general description of the problem that was investigated. A helpful discussion includes the history of previous work in the area, who did the work, and the conclusions drawn prior to the experiments covered by this report.

This section should conclude with a concise statement that identifies the scope of the investigation, its purpose and the content of the report to follow.

DESIGN OF

ZENER REGULATED

POWER SUPPLY

ACTIVE DEVICES
EET - 131

W. B. Kimble

(Jennifer Mains, Nathan Williams)

CHARLESTON, SOUTH CAROLINA

25 April - 2 May 2008

Submitted 9 May 2008

Figure 3-12 Formal Report Outline

TABLE OF CONTENTS

List of Illustrations	ii
Introduction	1
Objective	2
Theory	
Rectifiers	3
Filters	5
Procedure	7
Results	9
Conclusion	12
Recommendations	13
Appendix A, Derivation of Voltage Equations	14
Appendix B, Derivation of Filter Equations	16
Bibliography	18

Figure 3-13 Table of Contents

LIST OF ILLUSTRATIONS

FIGURE		PAGE
1	Half Wave Rectifier	2
2	Bridge Rectifier	3
3	Filter	5
4	Laboratory Equipment Set Up	6
5	Voltage chart	9
6	Regulation Curve	11
7	Recommended Equipment Set Up	13

Figure 3-14 List of Illustrations

OBJECTIVE(S):
State what you are attempting to accomplish by conducting the experiment. An experiment may have one or more objectives.

What are you trying to do? What are you trying to determine? What are you trying to demonstrate?

> **EXAMPLES:**
> The objective of this experiment was to identify the composition of a metallic specimen through the data obtainable from a tensile test of the specimen.
>
> The objectives of this experiment were to 1) determine the relationship between pressure drop and flow velocity for a liquid flowing through a pipe and 2) demonstrate laminar and turbulent flow.

THEORY:
The theory section includes a discussion of the operation and the scientific principles associated with the item or process investigated. It should include a discussion of the results expected in terms of measured quantities or observed actions. When applicable, the theory section may contain a mathematical analysis in which equations are developed for use in the Procedures or Results sections.

PROCEDURE:
The laboratory procedure section gives a clear presentation of the manner in which the laboratory work was accomplished.

A. Include a statement of the problem and the method used in its solution.

B. Describe the apparatus used and the measurements made, showing how and why the apparatus produced the desired information. Special apparatus should be described. Diagrams and drawings are recommended.

C. Explain the formulae to be used in the calculations and why they are applicable. Fundamentals and basic theory may be explained and (when applicable) their derivation shown. All symbols used in equations are to be defined and their units stated.

D. Use your own language; do not restate or list verbatim procedures given in the laboratory manual.

RESULTS:
The results section contains the data collected.

IDENTIFYING DATA:

The first item in the Results section is the name of the equipment tested and the name and identifying serial numbers of the measurement equipment. See Figure 3-4.

DATA TABLES:
A number of values are recorded in all experiments. Tables and charts are convenient methods for displaying data since all values are easily available for analysis. The guidelines for tables for formal reports are the same as those for memo reports. Never destroy a recorded datum even if it is later found to be incorrect. If a correction is made in a table, draw one line through the incorrect value and enter the correct value above it.

SAMPLE CALCULATIONS:
This section includes a sample of a complete calculation for each type of solution present in the experiment. The sample calculations are first shown in equation form, with each term properly identified. Identify each set of sample calculations with the table to which it applies. See Figure 3-5.

GRAPHS AND CURVES:
Graphs, to be included when applicable, offer the fastest method of interpreting data. The guides for producing graphs for a formal report are the same as those for a memo report.

ANALYSIS OF RESULTS
This section is the most important part of the report. As the name implies, it is a complete discussion of the results and should directly relate the "Results" to the "Objectives".

A. Include a discussion of the accuracy or reliability of the results. It is suggested that this section, when applicable, consist of a careful treatment of what effect the following had on the results:

   1. errors resulting from physical limitations in the performance of the test,
   2. errors in manipulation,
   3. errors in observation,
   4. errors in instruments.

B. Describe the steps taken to minimize errors.

C. Compare the results with the theoretical predictions. Discuss the probable reasons for observed discrepancies.

D. When results are given in graphical form, include an explanation of the cause(s) of the shape of the curve. Discuss the area under the curve or the

rate of change of the curve when these have significance. Give an ex ample(s) of how the graph is used to reflect the information; point out salient features of the graph, e.g. slope, maxima, etc.

RECOMMENDATIONS:
Criticism and suggestions for improving either the theoretical solution or laboratory investigation are necessary. All experiments, including ones that were not original, can be improved. Criticisms need not be constrained by the cost of equipment. In industry however, cost is important and recommendations for improvement must bear in mind the cost relative to the degree of accuracy desired.

APPENDIX:
If the development of equations is long and only the result is important, the development may be placed in the appendix and referred to in the body of the report.

BIBLIOGRAPHY:
All sources of published information must be identified by title, author, publisher, date and page numbers. Class notes are not published information and are not to be included in the bibliography.

GRADING:
See Figure 3-9. All formal reports will have a Laboratory Report Scoring Breakdown attached. The instructor will grade the report based on the criteria listed in the breakdown sheet; however, the points assigned and specific criteria used may vary among courses.