BRIGHAM YOUNG UNIVERSITY

Electrical Engineering Department

Standards for Daily Assignments with Suggestions for Effective Study

I. THINKING

One purpose of college education is to educate students in the art of thinking! The art of thinking is called logic. It is not possible, however, to learn to think by studying logic. Similarly, it is not possible to develop muscles by reading books on weight lifting. To develop "mental muscles," they must be exercised in vigorous mental activity. The mind can never be trained to solve difficult problems working on easy problems. Reasoning by analogy with physical training, it would appear that during the training period, in college, the mind must be disciplined by mental effort to equal to that which will be required in the future.

II. EFFICIENT STUDY

Studying requires a great deal of intensive effort. In order to conserve time, the effort should be concentrated and free from distractions. Efficient study can be made a habit which will be useful throughout a professional career. The fact that the student is actually self-employed provides an incentive for improvement in work habits. Reading is not study, and going through the motions will not produce results. Efficiency will be increased if the student periodically asks: "Why am I doing this?", "What is the best method?", "What should I be learning from this?".

III. ORDERLY WORK

It is absolutely essential that an engineer think and work in an orderly fashion. Since the ability to do so is developed by habit, students of engineering must make every effort to work problems, perform experiments, and write reports in a manner which is lucid and orderly. A sequence of steps which will be helpful in doing work in the desired fashion is:

(1) stating the problem
(2) planning the manner of solution
(3) executing the solution
(4) checking
(5) interpreting the conclusions

In interpreting the conclusions for a particular problem, one should endeavor to recognize the relationship of the specific case to the general class which it represents. One thinks, learns, and works best in the framework of general and fundamental principles. If one follows these in thinking, and if one presents work in corresponding fashion, there will be no doubt on one's part or anyone else's as to what the work represents.

It will be helpful to think of each assignment as engineering work for a client (perhaps yourself) who truly wants to know certain things. Consider that you are hired to find answers and to convince your client of their validity and importance.

IV. PROBLEM SOLVING AND PRESENTATION OF YOUR SOLUTION

As an aid in the solution of problems, it is advisable to follow a standard form. The purpose of the standard form is not to make all student papers look alike (although this is a great help for the readers), but to ensure that the student's thinking is organized during the process of organizing the work sheet.

A standard form for all daily assignments in the Electrical Engineering Department is to be used except in those cases where individual instructors explicitly authorize limited, stipulated deviations.

(1) Use of engineering problem paper ruled with five lines per inch for the bulk of calculations. The unruled side of the sheet is to be used even for graphs. (The lines show through well enough for most purposes.) Do not write on both sides of the sheets. On occasion, other forms of graph paper or charts or curves may be appropriate.

(2) Use a relatively hard pencil, well pointed. This can be erased and does not smudge excessively. Colored pencils for part of the work sometimes are helpful where contrasts between two or more conditions in the problem are displayed. However, it is well to avoid using red because this is the color graders normally use, and colors ordinarily do not differentiate on copy machines.

(3) The written part should be neatly lettered. Some instructors may permit longhand if it is exceptionally neat and legible.

(4) Do not crowd work. Leave one or more blank lines above and below equations.

A sample or a problem in the standard form follows. (This particular sample is from an elementary circuits course in which the student is learning to use Ohm's law and Kirchhoff's laws. Many of the steps shown here could be omitted by an advanced student, but one should still include explicitly the new concepts and principles illustrated by a new problem.)

The numbered comments below correspond to circled numbers on the sample. These numbers may be used by the grader to point out items needing more attention. it will be noted that the student is allowed considerable freedom to select details of format and presentation. The guiding principles are neatness, orderliness, completeness, and precision. Proper attention should be paid to spelling, grammar, punctuation, etc.

(1) Course number and section.

(2) Student name (A rubber stamp may be used to make a whole pad of paper quickly.)

(3) Date work is turned in

(4) Page numbering. The top number is that of the individual page; the bottom number is the total number of pages in the problem or assignment.

(5) Problem number from textbook or other source in the left margin.

(6) Statement of the problem. Normally this will not be worded the same as in the textbook.

(7) Circuit diagram or other sketch illustrating the problem as appropriate. This is part of the statement of the problem. Note that polarities of voltages and directions of currents (even for unknown quantities) are indicated along with component values. This is important. Show as much given data as possible and also show how the answers you are seeking relate to the circuit. Often input waveforms or signal conditions form part of the statement of the problem and should be shown on the sketch.

(8) A brief indication of the method of solution is normally helpful at the beginning. In the sample problem, other methods could have been used for solution such as superposition, Thevenin's theorem, nodal method, etc.

(9) Important equations are numbered for reference when they are used again.

(10) Left margin may be used for scratch work. If extensive scratchwork is required, a part of the center of the page may be blocked off for this purpose. Many mistakes are made in scratchwork so it is important to preserve all such calculations for orderly checking.

(11) Repeat headings on each page.

(12) Repeat problem number on each page.

(13) Box or heavily underline requested answers. Always indicate the units of the answers.

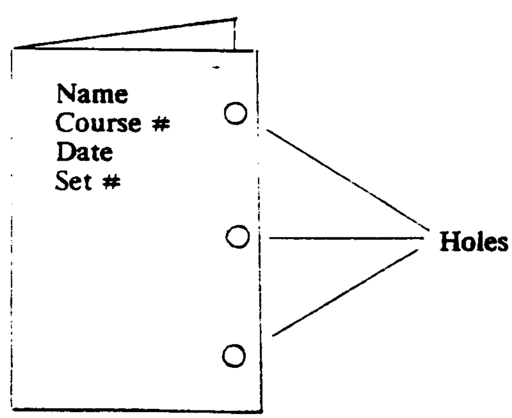
(14) Show answers on a sketch. The answers may be shown on the original sketch (Item 7 above if this can be done clearly.) In the illustrated problem, it seemed better to re-draw the circuit because the original diagram was getting cluttered and because the assumed current I_3 and voltage V_3 turned out to be negative. The circuit with the answers shown should be studied to see if it is reasonable. Quick checks on this circuit show that the voltages in each loop add up correctly and that the currents add up properly. Also, the current through the larger voltage source is in the direction expected for that source as must usually be the case in a dc resistive circuit. These checks need not be written out, but it is very important to take a minute or two to make them.

(15) New problem number or part.

(16) Comment or generalization or interpretation or something the problem illustrates is often called for here.

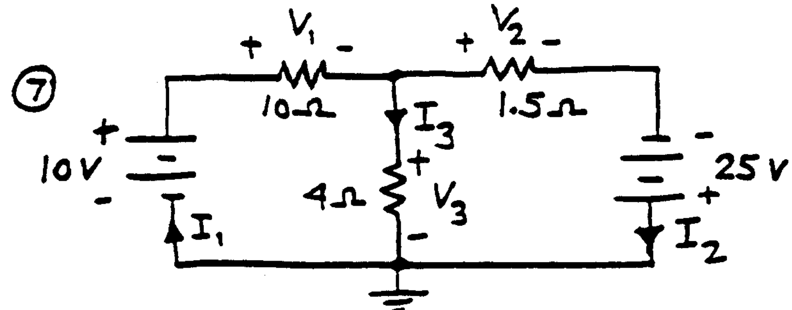
(17) Draw a long double line at the end of every problem and especially if there are several on the same page. Use the double line even if the problem ends at the bottom of a page. This is a signal that it is not continued on the next page. Usually on long problems, you will receive more personal satisfaction if you start each one on a new page. Sometimes you will get off to a bad start and want to begin again; this is hard to do if part of another problem is on the same page.

(18) For handing in assignments, fold them inward neatly once vertically and put name, date, course number and section on the outside top as shown along with any other information the instructor may require.



⑤ 2-18 (a)

⑥ All voltages and currents in the circuit shown are to be determined.

⑦


⑧ Kirchhoff's and Ohm's laws will be used.

KCL (Kirchhoff's Current Law) applied at the junction of the three resistors gives: ⑨

$$I_3 = I_1 - I_2 \qquad (1)$$

KVL (Kirchhoff's Voltage Law) for the left loop is

$$10 - 10I_1 - 4I_3 = 0$$

Using eq. (1):

$$10 - 10I_1 - 4(I_1 - I_2) = 0$$

$$14I_1 - 4I_2 = 10 \qquad (2)$$

KVL for the right loop is

$$25 + 4I_3 - 1.5I_2 = 0$$

Using eq. (1) this becomes

$$25 + 4(I_1 - I_2) - 1.5I_2 = 0$$

⑩ $$-4I_1 + 5.5I_2 = 25 \qquad (3)$$

4.0
1.5
5.5

Solving eq. (3) for I_2 and substituting the result into eq. (2):

$$I_2 = \frac{25 + 4I_1}{5.5} \qquad (4)$$

$$14I_1 - \frac{4(25 + 4I_1)}{5.5} = 10$$

$$14I_1 - \frac{16}{5.5}I_1 - \frac{100}{5.5} = 10$$

(12)
2-18 (a) cont.

$$14 I_1 - 2.91 I_1 = 10 + 18.2 = 28.2$$

$$11.09 I_1 = 28.2$$

$$I_1 = \frac{28.2}{11.09} = \boxed{2.54 \text{ ampere}} \qquad (5)$$

14.00
− 2.91
11.09

Using this last result in eq. (4):

$$I_2 = \frac{25 + 4(2.54)}{5.5} = \frac{25 + 10.16}{5.5} = \frac{35.16}{5.5} = \boxed{6.4 \text{ ampere}} \qquad (6)$$

From eq. (1),

−6.40
+2.54
−3.86

$$I_3 = 2.54 - 6.4 = \boxed{-3.86 \text{ ampere}} \qquad (7)$$

Voltages are found using Ohm's law:

$$V_1 = 10 I_1 = 10 \times 2.54 = \boxed{25.4 \text{ volts}} \qquad (8)$$

$$V_2 = 1.5 I_2 = 1.5 \times 6.4 = \boxed{9.6 \text{ volts}} \qquad (9)$$

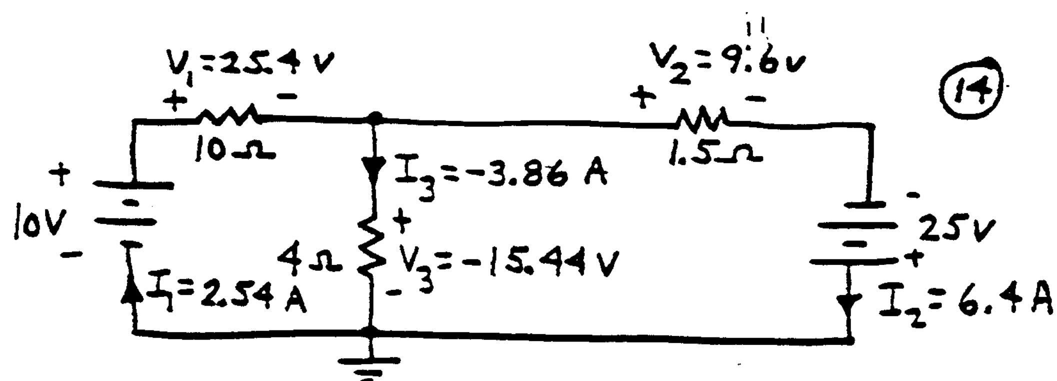
$$V_3 = 4 I_3 = 4 \times (-3.86) = \boxed{-15.44 \text{ volts}} \qquad (10)$$

check on answers

15.4
9.6
25.0

25.4
−15.44
9.96

2.54
3.86
6.4



(14)

(15) (b) Find the power loss in the 4Ω resistor

Using Joules law: $P = I^2 R = (3.86)^2 4 = \boxed{59.5 \text{ watts}}$ (11)

(16) ——— ——— ——— ——— ———

(17)

V. COMMON SENSE

There is no substitute for good judgment. A good deal of grief can be avoided in study and in professional practice by persistently applying common sense to the work.

VI. A GOAL OF ENGINEERING EDUCATION AND HOW TO PURSUE IT

Engineering courses are intended to form the mind, not just to fill the mind. To accomplish this, the courses are designed to develop a thorough understanding and appreciation of fundamental principles, the ability to analyze a problem or situation, and the ability to apply principles to new situations. These objectives are not achieved by mere presence in the class or by learning equations and other material by rote. To enable these benefits to accrue, you must work and work hard.

It is far better for you to have studied the portion of the textbook which is discussed in class prior to, rather than after, the classroom session. The time involved in either procedure is approximately the same. However, by studying the text before the session, you can determine which points are not clear to you and can have them clarified through class discussion. This procedure will pay dividends when you are solving problems dealing with the text material. Just reading the text is not studying; it is only the first step. In studying, you must reconstruct the ideas expressed in the text so that they are meaningful to you. You must think constructively about the materials, not memorize it. Memorizing is of practically no value and may lead to serious difficulties. Supplementary reading in other books and in journals is of considerable assistance in clarifying a concept and in getting different points of view about a topic. If you must miss a session, it is only reasonable that the work which was covered in the class be made up. Failure to make up work will affect your understanding of subsequent topics that depend on the concepts which should have been mastered previously.

The shorter and easier a solution, the less chance there is of error. It pays, for this reason alone, to analyze a problem before proceeding with the solution.

VII. CHECKING NUMERICAL RESULTS

Everyone makes mistakes! How then can we ever have confidence in engineering calculations? The answer comes from checking. All successful engineers have developed (and engineering students can develop) the ability to determine with confidence whether or not a solution is correct. This starts with the realization that a mistake can be made at any point in a solution -- more often in the simple steps; so, every step must be checked as a calculation proceeds. Even the use of an electronic hand calculator does not exempt one from making checks or results, for incorrectly pushed buttons or even round-off in some problems yield errors.

An error detected too late in a solution leads to the loss of the advantage inherent in the use of a good method. An engineer must assume that there will sometimes be mistakes made and must proceed accordingly, checking as the solution proceeds. Here is an apt statement:

> "Engineering work not thoroughly checked for correctness has little value. In the practice of the engineering profession, there are no answer books, nor can you check with a classmate, for, although engineers often work in groups, the group is usually a team with each individual alone responsible for ... part of the job."[1]

Reliability is more important than speed.

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[1] D. W. VerPlank and B. R. Teare, Jr., Engineering Analysis, An Introduction to Professional Method (New York: John Wiley & Sons, Inc., 1954), p. 229.

There are many ways of checking results. The one most frequently used and one that gives the most complete check is to repeat a calculation, when such action is possible, by using an alternate method or by taking the numbers involved in the calculation in a different order. The most rapid method of checking is known as the method of approximation. This method is not used often enough. Many errors in calculations can be detected by replacing the given numbers by other numbers which are reasonably close in value and more convenient to use. Making the calculations with these simpler numbers enables an approximate result to be computed and its magnitude to be compared with the previously determined results. Very frequently the entire approximate calculation can be performed mentally. Although the method of approximation does not check a result exactly, it is very effective in indicating whether a result is reasonable.

A simple example of the use of the approximation method is finding the value of

$$\sqrt{(21.4^2 + 16.1^2)}.$$

The result obviously must be more than 21.4 and less than 37.5.

A closer limit of the result can be obtained by approximating the given expression to be

$$\sqrt{(20^2 + 15^2)}.$$

This becomes $\sqrt{625}$ or 25. It is unthinkable that a result of 37.8 or 24.8 would be accepted without question. Another example is the determination of sin(35°) on a calculator. We should estimate what we expect the approximate result to be while obtaining the desired value, and should stop short if we obtained 0.798 as the answer (sin 53°). Knowing that sin(30°) is 0.500, we should expect the value of sin(35°) to be only a little larger. The procedure for estimating the location of the decimal point for calculations will also check the rounded first significant figure of the result.

The least excusable of all errors is a misplaced decimal point. Such an error is valid testimony that checking has been neglected and, worse, that the one making the calculations has so meager an understanding of what he is about that an unreasonable result can go unnoticed.

VIII. SUMMARY

Each aspect of the homework from thoughtful, questioning reading to checking of neat, well-organized calculations has a definite part to play in the education and morale of the student. The final stages of checking and interpreting are the ones which bring satisfaction -- the assurance that the subject material has been understood and correctly applied with meaningful results. WOULD YOU BE WILLING TO LET YOUR HOMEWORK REPRESENT YOU?