

# Homework Hints - Engineering

Items that may affect your score. D. Dal Bello, revG: 7/9/19

## GENERAL

1. Use the **specified format**. Show that you can **follow directions** and communicate in the expected layout. The first rule of homework: "Make the grader happy."
2. Read the questions carefully so that you answer all parts, and answer the correct (!) question.
3. Write **neatly/legibly**.
4. **Communicate**. Give **clear explanations** (in words, equations and figures) that demonstrate your thought process. Do not keep it in your head ... even if you can do it in your head, explain what you are doing. If answers suddenly appear without explanation, what is the grader supposed to think?
5. **Draw and label pictures/sketches**; they are usually part of analyzing and communicating what is going on. Equations come from **FBDs, figures, circuit schematics, graphs**, etc.  
If a variable appears in an equation and it comes from a picture, it better be labeled on the picture.  
**No labeled picture, no equation.**  
Make it clear which dimension is  $d$ , which current is  $i_2$ , etc. Do not make the grader figure it out.
6. Practice drawing in three-dimensions.
7. Use a **ruler** when drawing pictures.
8. Include the coordinate system/origin.
9. **Draw to scale** (use the engineering paper's grid).
10. Draw angles close to scale. Do not draw every triangle 45-45-90° (I have even seen angles greater than 45° labeled as 30°).  
If a triangle is, say 40-50-90°, consider exaggerating the angles away from 45°; e.g., draw it 30-60-90°, so it is easy to see which angle is smaller (so you know which trig. functions to use).
11. **Shade/cross-hatch** the ground.
12. **Dimension lines** have **arrowheads** at **both** ends (from "here to here"). A line indicating position from an origin (distance and direction) has only has one arrowhead – at its end.
13. **Show your work**; do not just write down a numerical answer. No work = copied. Justify your result/explain how you get the answer (what theory are you applying? show the algebra).
14. **Box your final answer.**
15. Include **units** – they are part of the answer.
16. The abbreviation of *pounds* is **lb**, not lbs.
17. The unit of moment (torque) is **N·m**, not Nm.
18. Engineers use mm for small dimensions, not cm.
19. **DO NOT copy** another student's work.
20. **DO NOT just copy published solutions**, etc.
21. **Check your work**. Do the units make sense? Is there an equation that you haven't used that can be used to verify your answer.

22. If you use content from the book or other source, cite the reference. If you quote text, use quotation marks. Better yet, **use your own words** so you show you understand.

## MATHEMATICS

1. Watch your **algebra**. Do not do multiple steps in your head (you will multiply when you should divide, add when you should subtract, etc.)
2. Be able to quickly model linear equations ( $y=mx+b$ ); linear equations appear a lot  
Do not get stuck using only  $x$ - $y$  coordinates; variables might need to be different:  $r = my + c$
3. Simplify the final answer as much as possible; factor out common terms, reduce results, etc.
4. Do not place a fraction within a fraction.
5. Do not mix decimal and fractional numerals in the same expression.
6. Know **vector** algebra: addition, cross-product, dot-product, etc., and what each physically means.
7. Clearly indicate a vector with an over-arrow or underline:  $\vec{F}$  or  $\underline{F}$ , e.g.,  $\underline{F} = 3\hat{i} - 4\hat{j}$  kN.  
Unadorned letters are scalars, e.g.,  $F = 5$  kN.  
**Do not** mix vectors and scalars: e.g.:  
 $F \neq 3\hat{i} - 4\hat{j}$  kN,  $F \neq 5$  kN
4. Know the difference between a *scalar component* ( $F_y = -4$  kN) and a *vector component* ( $\underline{F}_y = -4\hat{j}$ kN).
5. Know common right-triangle ratios:  
 $1-1-\sqrt{2}$ ;  $1-\sqrt{3}-2$ ;  $3-4-5$ ;  $5-12-13$
6. Do not be sloppy with **calculus**. The integral of  $f(t)$  is written:  $\int f(t)dt$ ; **not**  $\int f(t)$ . The integral of  $x+3$  is  $\int (x+3)dx$ , not  $\int x+3dx$  (use **parenthesis**).
7. Understand that the **derivative** of a function is its **slope** or **rate of change**, and what it means in the context of the problem.
8. Understand that the **integral** of a function is the **area under its curve**, and what it means in the context of the problem.
9. Know how to **quickly and correctly take derivatives** and **integrals** of polynomials (and  $1/x$  and  $\ln x$ ), sine and cosine, and exponentials.
10. Know the **chain, product** and **quotient rules**.
11. Use the table of integrals in the back of the book.
12. Solve  $2 \times 2$  systems of equations by hand. Know Cramer's Rule.
13. Use appropriate **sign convention**; be consistent.
14. Inverse trig functions have two solutions in  $360^\circ$ , but your calculator reports only one value.  
Your calculator displays one angle as follows:  
 $-90^\circ \leq \text{asin}(x) \leq +90^\circ$ ;  $0^\circ \leq \text{acos}(x) \leq +180^\circ$   
 $-90^\circ \leq \text{atan}(x) \leq +90^\circ$   
Make sure you determine the correct angle.

## NUMBERS

1. The **magnitude** of a quantity is always a **positive number** (read questions carefully).
2. Write the **final answers to 3 significant figures/digits** (4 digits is acceptable if the number starts with a 1). Assume all textbook data is good to 3 significant figures. NEVER write final answers to all the digits your calculator can display!

**Exception:** for numbers that are exact 1- or 2-digit integers (1,2,3...99), you may write 1 or 2 sig-figs. E.g., if a quantity is exactly 30 meters, write 30 m. But 0.3 m should be written 0.300 m.

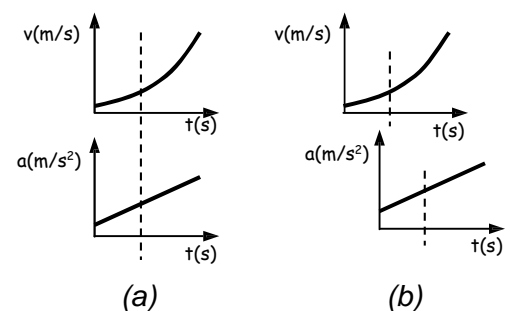
**Note:** we are not really using the formal rules for sig. figs for textbook problems. However, for **lab work** you must **always** use the correct rules for sig. figs. [See *Significant Figures* handout].

3. Write **final answers for angles** to one decimal place, e.g.,  $15.2^\circ$ , not  $15^\circ$ , not  $15.23^\circ$  (angles do not follow the standard rules for sig. figs).
4. **Do not round too soon** (keep unrounded numbers in your calculator). Numbers in intermediate calculations should be taken to 4 or more digits. Angles in intermediate calculations should be to at least two decimal places  $0.xx^\circ$  (depending on the angle, values of trig. functions and inverse trig. functions can vary significantly over small changes in angle).
5. Write numbers less than 1 (one) with a zero in front of the decimal point (e.g., look at your textbooks). *One-half* is "0.5", **not** ".5". With no zero, the decimal point might be missed, the reader might wonder if there should be a non-zero number in front, or if the decimal point should be there at all (is it a stray mark?). **Remove any ambiguity** by writing a zero in front of the decimal point.
6. Use **Engineering Notation** to keep numbers between 0.1 and 1000. Avoid *Scientific Notation*. The rule for Engineering Notation is that the exponent must be divisible by 3, to agree with the **standard S.I prefixes** (every 3 orders of magnitude). e.g., to write 23,400 N  
in Engineering Notation:  $23.4 \times 10^3$  N  
in Scientific Notation:  $2.34 \times 10^4$  N.
7. The use of **SI prefixes** (p, n,  $\mu$ , m, k, M, G, T) is preferred; e.g., write: 23.4 kN, not  $23.4 \times 10^3$  N.
8. NEVER write calculator form: 2.34E4.
9. Is your calculator in radians or degrees?

## GRAPHS

1. The horizontal ("x-axis") is the **abscissa**; the vertical ("y-axis") is the **ordinate**.
2. A graph of "**a vs. b**" means plot *a* on the "y-axis," and *b* on the "x-axis" (**a is a function of b**).
3. The **bottom of a graph** (the abscissa) is always positioned towards the bottom of the page, or towards the right side of the page.

4. Use a **ruler**.
5. Draw **graphs so that they can be easily read** – do not crowd them into a corner.
6. Draw **to scale** (that's why engineering paper has gridlines that show through to the front).
7. Use **tick marks** and evenly spaced intervals.
8. Use **standard evenly-spaced numerical labels**. The standard scale labels are: "0, 1, 2, 3, 4...", "0, 2, 4, 6, 8...", "0, 5, 10, 15, 20...", and multiples of  $10^n$  of these scales ("0, 100, 200, 300...", "0, 0.2, 0.4; 0.6...").  
We live/think in a decimal world... 10 and its factors 2 and 5 are easy for us to interpret on a graph. While 0, 7, 14, 21 are evenly-spaced, what is three-fourths of the way between 7 and 14?
9. Use the engineering paper's grid effectively; e.g., 7 squares = 100 units is not effective; 5, 8 or 10 squares = 100 units is better (think about presentation and analysis).
10. **Label the axes** with their **variables** and **units**.
11. If you plot **several functions against the same variable on different plots**, use the **same scale and align the plots horizontally**. E.g., when plotting velocity and acceleration vs. time, a **vertical line should pass through the same time (Figure 1)**. This makes it easier to interpret what's going on.... your eye only moves one direction.
12. If **several functions are plotted on the same set of axes**, directly label the functions (including their units if the units of each set are different). A legend is usually not needed.
13. Do not differentiate curves with only colors. If you print/copy in grayscale, which gray curve is the "orange curve"? Also, some people are color blind. Distinguish curves with different markers (symbols) or different line types (solid, dashed, dash-dot, etc.).



**Fig. 1** Two sets of graphs, plotted against the same variable (time  $t$ ). **Align the horizontal axes** so that a vertical line passes through the **same time** on each graph, as in the **left set (a)**. Corresponding values of  $v$  and  $a$  are difficult to read on the **right set (b)**.

Also, use the same scale for time on both graphs.