Engr. 154, 156 and 170/171: What I expect you to know (partial list)

D. Dal Bello 1/08/20

The following are second-semester **sophomore-level engineering courses**.

- ***Dynamics*** (Engr. 154)
- ***Strength of Materials*** (Engr. 156)
- ***Electric Circuit Analysis*** (Engr. 170)

By the time AHC engineering students reach the second half of their sophomore year, they should have completed these fundamental courses:

English 101	Math 184	CompSci. 111
Math 181	Chem 150	Physics 161
Math 182	Chem 151	Physics 163
Math 183		

You should remember all your mathematics up to at least Calculus 2 (Math 182) – or know where to look to review key concepts. A pre- requisite of Math 182 implies that you have knowledge of (and skills from) all of the math courses *up through* that one; the pre-req. of Calculus 2 is Calculus 1, the pre-req. of Calculus 1 is Pre-Calculus of Pre-Calc. is… etc. A student once asked me – when we were working on a 3D problem requiring trigonometry and geometry – "The pre-requisite is only Math 182. How far do we have to go back?" My answer: "All the way to kindergarten."

The ***prerequisites*** for *Dynamics* and Strength of Materials are Engr 152 (*Statics*) and Math 182. The perquisites for *Electric Circuit Analysis* are Physics 163 and Math 184.

Some Important <u>MATH TOPICS</u> and <u>SKILLS</u> to:

KNOW, BE ABLE TO DO and BE FAMILIAR WITH

Algebra. Know:

- **how to solve basic equations**.
- how to manipulate fractions correctly.
- <u>Caution</u>: Many students try to solve equations in their head, but often make serious mistakes, e.g., $2x = 3$ does not result in $x = 6$. Make sure you are careful with your math – not only do the math, but think about if you did it correctly.
- <u>Do not</u> do <u>multiple</u> steps in your head. Write them down, else you will add when you should subtract, multiply when you should divide, etc.

- to use **parenthesis**: e.g., it is $\int(x+1)dx$, <u>not</u> $\int x+1 dx$.
- the **Quadratic Formula** (besides, it exercises your brain).
- how to solve **systems of equations**. You must be able to solve 2×2 systems *by hand* during exams. Cramer's Rule is a powerful tool.

  Systems that are 3×3 and higher can be solved in HW on your TI-8x calculator, or with MATLAB, or by hand.

Trigonometry and Geometry. Know:

- the definitions of sine, cosine, tangent, cosecant, secant, cotangent [see Vectors].
- inverse trigonometric functions.
- that inverse trig functions have two solutions in the 360-degree circle.
- basic trigonometric identities, or more importantly, that they exist, can help you solve problems, and where to find them.
- the Law of Sines, Law of Cosines.

- properties of triangles and intersecting lines.
- the Pythagorean Theorem.
- the ratio of sides of common right triangles:
    1-1-$\sqrt{2}$; 1-$\sqrt{3}$-2 ; 3-4-5 ; 5-12-13
- complementary and supplementary angles, and related trigonometric functions.
- the areas of circles, parallelograms (rectangles, squares) and triangles.

Continued on reverse

Numbers, Units, Dimensions. Know:

- the Rules of Significant Figures.
- how to use Engineering Notation (not scientific notation.
- the U.S. and S.I. units for force, mass, distance, time, etc.
- the S.I.-prefixes: p, n, µ, m, k, M, G
- that pounds is abbreviate lb, not lbs.
- that torque is N•m or lb-ft, not Nm or lbft.
- That engineers use mm, not cm, for small distances in S.I. units.
- that **dimension lines** have arrowheads at both ends.
- that a variable distance from an origin has one arrowhead – at the end. This indicates both distance and direction (sign).

Vectors. Know:

- 2D Cartesian/Rectangular (*x-y*) and *Polar* (*r-θ*) coordinates.
- 2D Vector Notation/Representation:
$$\hat{\imath} - \hat{\jmath} \; ; \; \underline{e}_r - \underline{e}_\theta$$
- that vectors are written out with over-arrows, underlines or hats ($\vec{F}$, $\underline{F}$, $\hat{\imath}$) ; scalars are not (*F*).
- the **Cross-Product** (Vector-Product), and **Dot-Product** (Scalar-Product), and methods to calculate them.
- that we will work with 3D vectors:
$$\hat{\imath} - \hat{\jmath} - \hat{k} \; ; \; \underline{e}_r - \underline{e}_\theta - \hat{k} \; ; \; \underline{e}_R - \underline{e}_\theta - \underline{e}_\phi$$

Calculus. Know:
Derivatives and Integrals of:

- polynomials.
- $1/x$ and the natural logarithm ln$x$.
- $1/x^n$ and similar forms.
- sine and cosine; derivative of tangent.
- exponentials.

Linear Algebra and Differential Equations:

- solution to systems of equations using matrix methods.
- solution of first and second order systems.

Rules/Techniques:

- Integral tables, where to find them, how to use them.
- Product Rule.
- Chain Rule (functions within a function).
- Quotient Rule (or rearrange into Product).
- single- and double-integrals.
- "u-sub" (although many of you use u-subs more than necessary, e.g., $\int[1/(x+1)]dx$; **recognizing patterns saves time**.
- integration by parts.

WORD and EXCEL

Word. Know how to:

- to create/use tables.
- create/use equations.
- format reports and documents.
  - insert figures and tables.
  - format and number equations.

Excel. Know how to:

- work with formulas.
- create report-quality plots.
- use Excel to solve problems.
- label Excel graphs correctly.

Format for Reports, etc.

Italics. Know that:

- variables are italicized.
- numerals and units are <u>not</u> italicized:
  - F = 30 N, <u>not</u> F = *30 N*.

Figures. Know that:

- all images, pictures, sketches and graphs are labeled as ***figures***.
- the title of figures are <u>below</u> the figure.

Tables. Know that:

- tables are NOT ***figures***.
- the title of tables are <u>above</u> the table.