Engr. 152 and 161: What I expect you to know (partial list)

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Statics (Engr. 152) and ***Materials Science*** (Engr. 161) are **sophomore-level engineering courses**.

By the time engineering students reach their sophomore year, they should have completed these fundamental courses (have you?):

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

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, the pre-req. 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 *Statics* are Physics 161 and Math 182. The perquisites for Materials Science are Physics 161 and Chemistry 150.

In fall of your sophomore year (when you are taking *Statics* and *Materials Science*), you should be enrolled in – or have already completed – Calculus 3 (Math 183), in not Calculus 4 (Math 184). By the time you are in ***Electric Circuits Analysis*** (Engr. 170), you will have taken Phys. 163.

Some Important MATH TOPICS and SKILLS to: KNOW, BE ABLE TO DO and BE FAMILIAR WITH

Algebra. Know:

- **how to solve basic equations**.
- how to manipulate fractions correctly.
- Caution: 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.
- Do not do multiple 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 $\int(x+1)dx$, not $\int x+1dx$.
- 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:

  $1\text{-}1\text{-}\sqrt{2}$; $1\text{-}\sqrt{3}\text{-}2$; 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 abbreviated 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.

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 a figure is <u>below</u> the figure.

Tables. Know that:

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