How to Approach Homework – and Why!

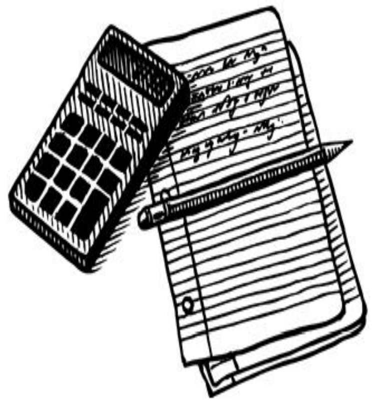
- Homework! The name strikes fear into students everywhere!
- Well, not everywhere. In many cultures, students embrace homework, realizing it is the key to mastering a subject, preparing them more fully for adult life.
  - Here in the USA, students do not seem to embrace homework that same way. Hence this lecture.
  - Some of you from foreign cultures may feel that the following is so self-evident that you can't imagine that I would so waste your time.
  - In that case, just lean back and act smug, because this lecture is aimed squarely at American students!

Homework: Learning by Doing

- **Generally, homework gives you the opportunity to apply knowledge covered in class.**
- **Since, by necessity, lectures are packed very densely with information, it is hard if not impossible to master all the concepts sitting in the classroom.**
- **As a matter of fact, you are not intended to!**
- **The various kinds of homework in ECS 1200 (and other courses) are structured to enable learning and learning reinforcement for the topics covered in class.**
- **Homework is your opportunity to lock on to key course topics and make them your own!**

Kinds of Homework and Their Purpose

- **In general you will have three types of homework in all your classes (although not necessarily all three in every class):**
  - **Class notes: Rewriting and reorganizing, both for your benefit and to turn in for a grade. We talked about this in Lecture #3. Also, as mentioned in Lecture #2, each of us has a primary learning mode – visual, aural, and tactile. Rewriting homework is an extremely important reinforcement technique, as writing is a tactile reinforcement, and reading the reorganized notes is a visual reinforcement. Read the notes aloud and you have completed the reinforcement trifecta!**

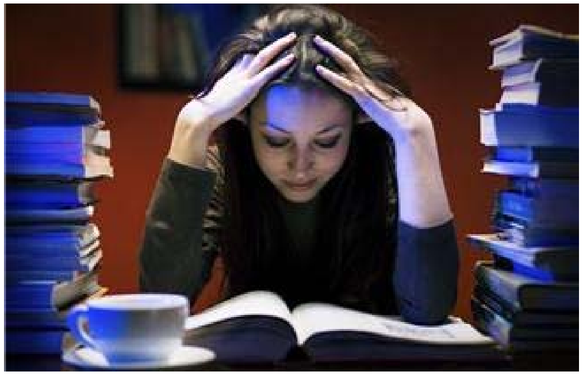


Kinds of Homework and Their Purpose

- **Homework problems: In engineering and computer science, homework problems are very important, perhaps even more than in disciplines such as language or the arts. In the technology areas, problems that allow the application of technical principles can broaden the knowledge set as well as reinforce class lecture material.**

- **Laboratory exercises: Homework that "reinforces learning by doing." The ability to write lines of code or build a circuit or mechanical device enhances learning, especially when students work in teams. The reinforcement is again multiplied by all three learning channels.**

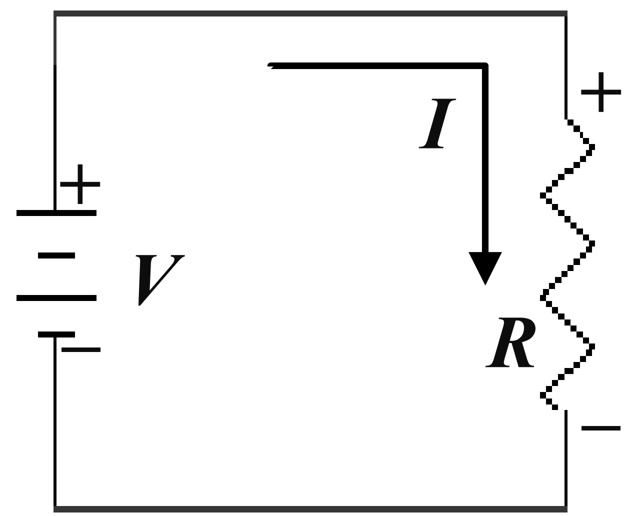
Homework Problems



- **We have already discussed taking notes and rewriting and reorganizing them. Here, we will discuss mainly homework problems.**
- **Homework problems give students the chance to assure that they have understood the lecture material that was first re-studied by the note-taking process above.**
- **Further, homework can broaden the learning, as students apply the knowledge from the lecture, allowing the acquisition of new principles.**
- **The following example shows the benefit of solving problems as a way to master material.**

Lecture Excerpt

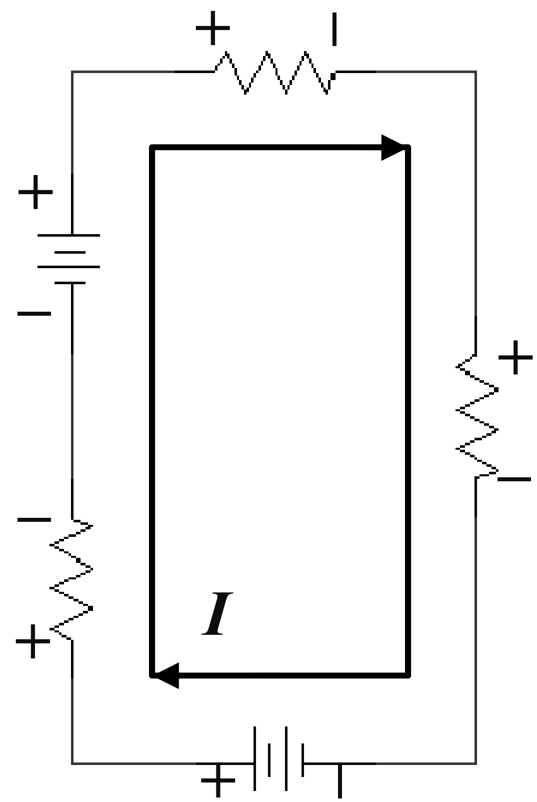
- **Ohm's Law: The voltage across a resistor is equal to the current in the resistor times the resistance, voltage in Volts, current in Amperes, resistance in Ohms: $V = I \cdot R$**



- **Note: Amperes x Ohms = Volts**

Kirchoff's Loop Voltage Law

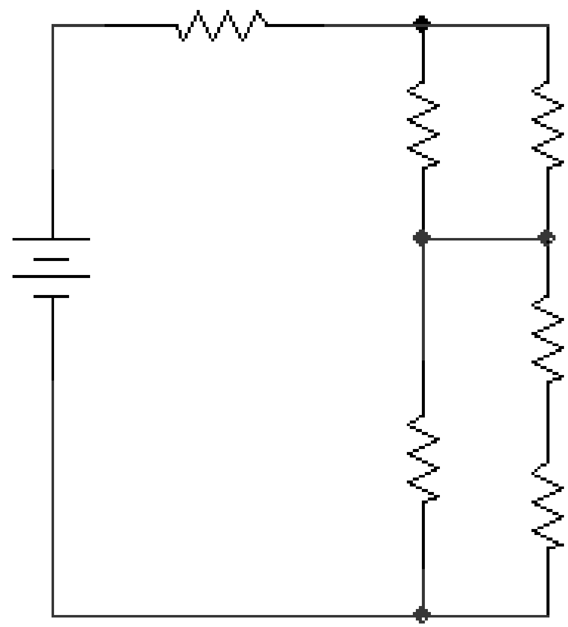
- **KVL: The net voltage around a closed loop circuit is zero.**
- **Another way to state this is that the voltage rises (sources) in a closed loop equal the voltage drops (caused by resistors).**



Resistor Value Relationships

- When resistors are connected in series ("in-line"), their total resistance is cumulative. That is, if two resistors with values of 100 Ω and 50 Ω are tied in series, the resultant resistance is 150 Ω.
- When resistors are connected in parallel ("side-by-side"), their resistances add such that the reciprocal of the total resistance = the sum of the reciprocal resistances of the resistors in parallel.

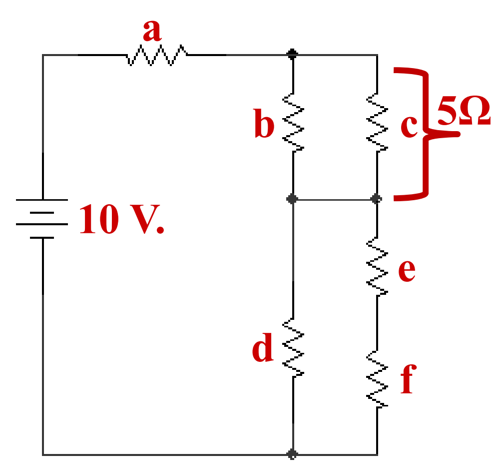
A Homework Problem: Resistor Circuits



- **In the DC circuit above, the battery is 10 volts and all the resistors are 10 Ω. What is the current flowing out of the battery?**

First Parallel Resistor Set

- **Consider the circuit.**
- **We know that resistor a is part of a series resistor connection, but unfortunately we cannot add it to anything, as the other parts of the connection consist of parallel resistors.**
- **We need to start in the parallel elements and determine their value. Then we can add them to resistor a.**
- **First lets find the resistance of the parallel connection of resistors b and c .**



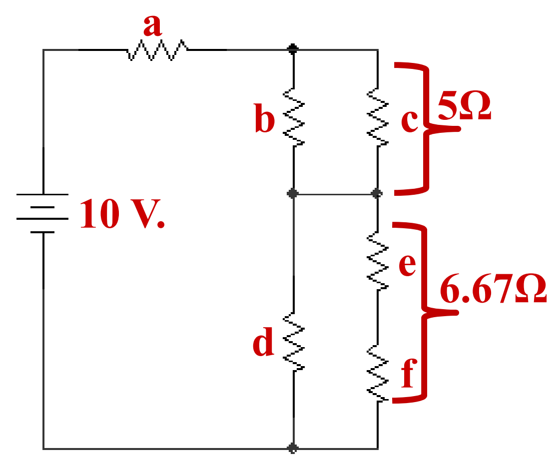
We know that $1/R_{parallel} = 1/R_b + 1/R_c$

Then $1/R_{parallel} = 1/10 + 1/10 = 2/10 = 0.2$

Or $R_{parallel} = 1/0.2 = 5\Omega$

Second Parallel Resistor Set

- **Now consider the second set of parallel resistors:**
  - **e and f are in series, and their series resistance is in parallel with d.**
  - **We can find this equivalent resistance in two steps, as shown below.**



Here $R_{series} = R_e + R_f = 10 + 10 = 20\Omega$

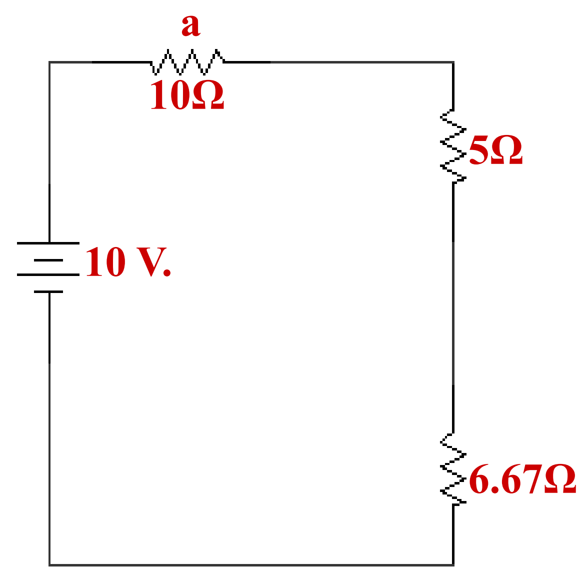
Then $1/R_{parallel} = 1/R_d + 1/R_{series} = 1/10 + 1/20$

Or $1/R_{parallel} = 3/20 = 0.15$

Or $R_{parallel} = 1/0.15 = 6.67\Omega$

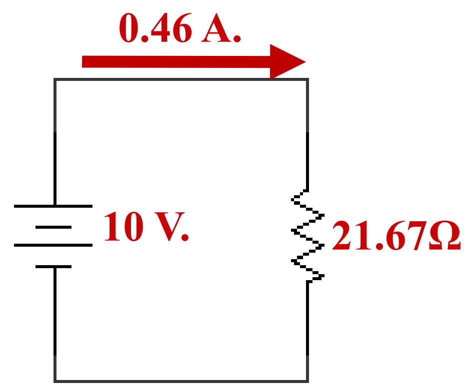
Adding Series Resistors

- Our circuit is now represented as three series resistors, and as we know that resistors in series simply add cumulatively, then the total resistance of the circuit shown is (10 + 5 + 6.67) Ω, or 21.67 Ω.



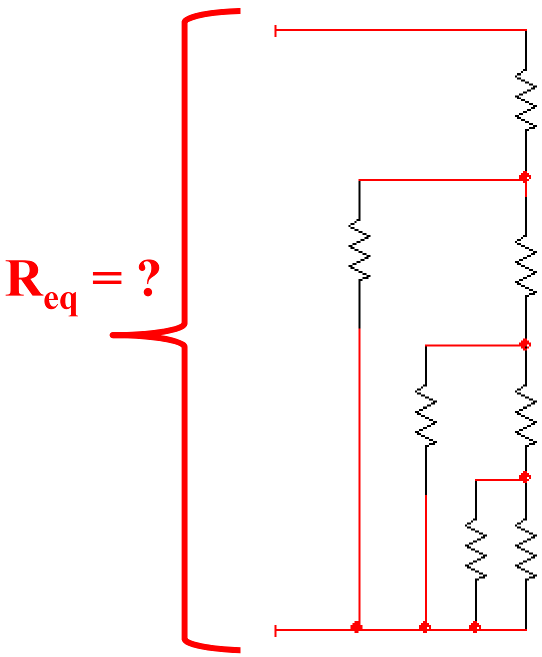
"Ohm's Law" Circuit

- We now have a VERY simple DC circuit with only a resistance and an applied DC voltage. Since $V=I \cdot R$, then of course, $I = V/R$, or:
  $I = 10/21.67 = 0.46$ Amperes.
- By applying the homework lecture information (looking back at the principles, understanding them, then applying them), we were able to solve the problem.
- But we also gained additional knowledge: We learned how to analyze a circuit with multiple resistances, deconstruct them, and solve a more complex problem!

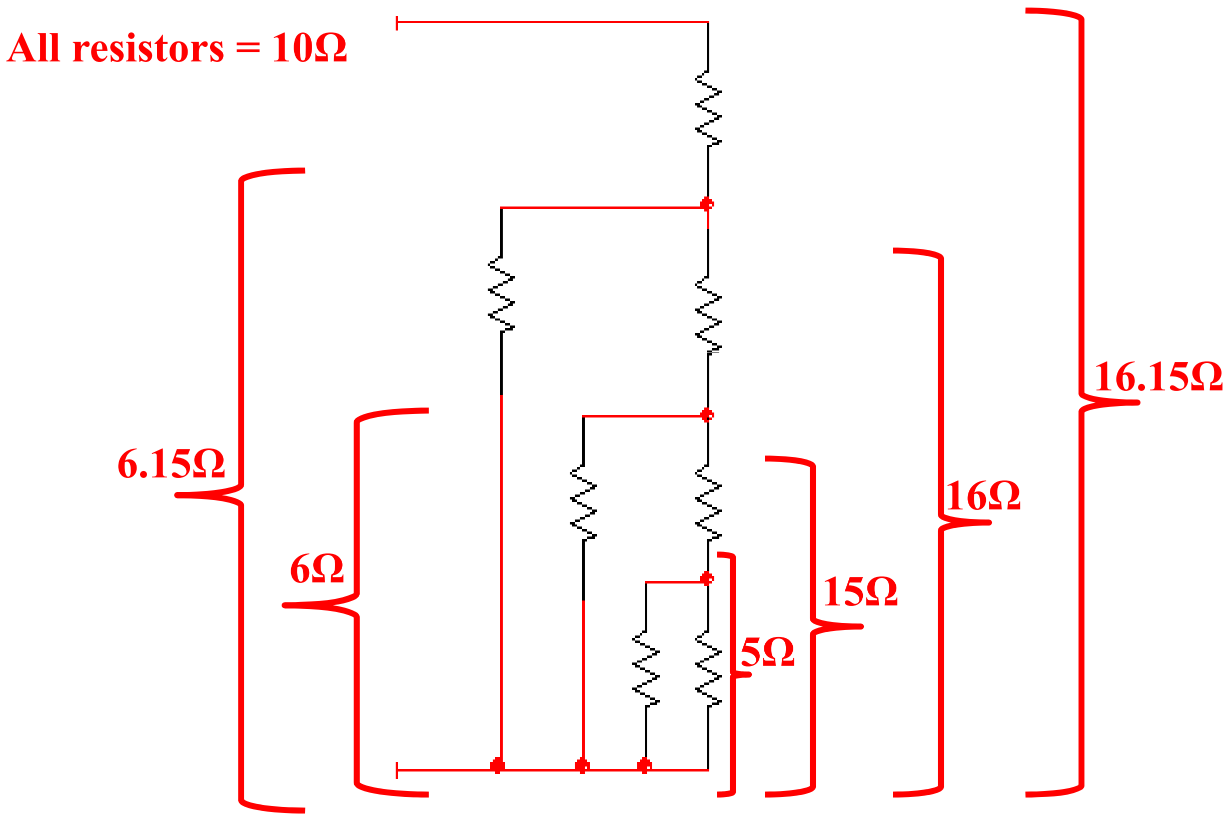


Problem Exercise

- **Whether you will take electrical engineering or not, you now have the tools to figure out resistance values.**
- **Given that knowledge, <u>find the equivalent resistance of the network on the right</u>. All resistors are 10Ω.**



Solution



Recap

- **The preceding problem illustrates two important facts about homework:**
  - **First, if you did not completely understand the concepts of resistance, attacking the problem probably brought the concepts together so that your knowledge improved.**
  - **Second (probably even more important), the resistor problem clearly illustrated the concept of breaking down the problem into bite-size pieces, each of which (except for the irritating math) is relatively easy. Looking at the overall problem, the solution is not clear. Solving "piece at a time" makes the problem much more straightforward.**

Another Example

- **From basic physics, if a body is accelerating, the force required is equal to the mass times the acceleration. Thus, $f = m{\cdot}a$. If the mass is in kilograms and the acceleration is in meters per second per second (m/(sec)^2), then the force is in Newton's.**
- **The kinetic energy of a body is related to the force exerted on it times the distance traveled. Assuming f in Newton's and distance d in meters, then the energy is measured in joules.**
- **Use this information to find a formula for kinetic energy and the equivalent fundamental units of joules.**

Solution

- **Since $f = m{\cdot}a$, then $f = m{\cdot}(d/t^2)$.**
- **Kinetic energy = $f{\cdot}d = m{\cdot}(d/t^2){\cdot}d = m{\cdot}(d^2/t^2) = m{\cdot}(d/t)^2$**
  Or, KE = $m{\cdot}(d/t)^2 = m{\cdot}(v)^2 = m{\cdot}v^2$.
- **The arrived-at formula is in fact the correct formula for kinetic energy of a moving object.**
- **As mentioned, energy is usually expressed in Joules. But what are the fundamental units of kinetic energy? KE = $m{\cdot}v^2$ = kg(m·m)/(sec·sec).**
- **Thus we can say that the fundamental units of Joules are kilogram-meters-squared per second-squared.**

Another Exercise

- The acceleration due to gravity is ~9.81 m/sec^2. A five kilogram rock is dropped off a cliff and falls 10 meters to the ground below. When the rock contacts the earth, what total kinetic energy is transmitted into the ground?

Solution

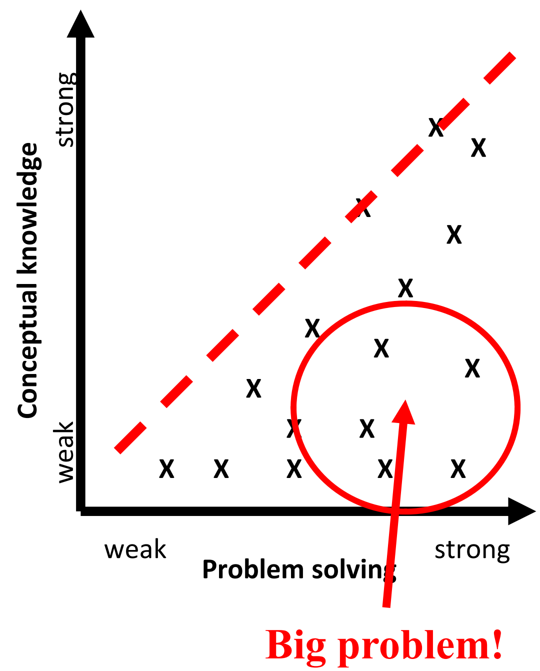
- We have $f = m \cdot a$; KE $= f \cdot d = m \cdot a \cdot d$ (m = mass, a = acceleration, d = distance)
- Here, m = 5 kg, a = 9.81 m/sec^2, d = 10 m.
- Then KE = 5·9.81·10 kg(m-m)/(sec-sec) = 490.5 (kg-m^2)/sec^2 = 490.5 Joules.

A Homework Methodology

- **What the previous examples show is that the act of doing the homework can highly reinforce lecture concepts.**
- **Homework is VERY valuable to every student.**
- **Despite its usefulness, homework can be "gamed." That is, a student may apply a "plug and chug" mentality to his/her actions and thus develop a mechanical problem "completing" ability that does not convey the true principles and knowledge of the subject.**

Methodology (2)

- **Studies have shown that if a student's conceptual knowledge is plotted vs. problem solving ability, a plot like the one shown at right results.**
- **Why might this be true?**
- **Someone who solves problems by rote ("plug and chug") generally cannot solve variants on the problem, since he or she finds if hard to adjust to new problem conditions.**
- **On the other hand, if a student understands the topic on a conceptual level, homework problems are typically straightforward.**

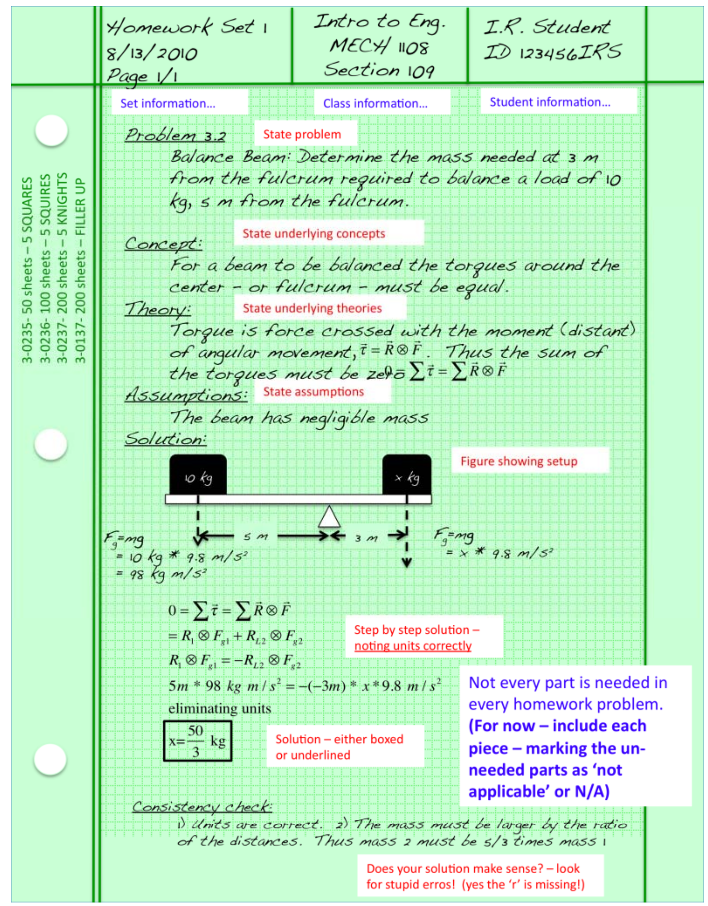


Methodology (3)

- **Because even doing the homework mechanically cannot guarantee acquiring solid course knowledge, we require a structured, organized approach that can, if done properly, reduce the "mechanics over knowledge" learning method and improve problem solving ability and fundamental course knowledge.**
- **This has already been discussed, but as of this lecture (and particularly for the semester project), we require the following for ECS 1200 (and strongly suggest the approach for all your CS, engineering, science, and mathematics courses).**

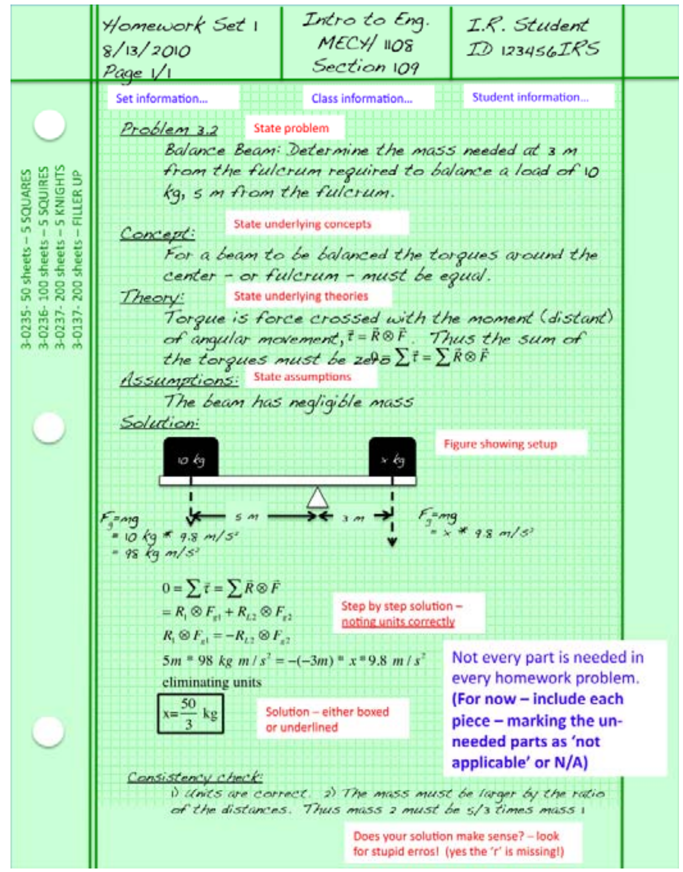
Neatness Counts!

- **This homework sheet (from ME department, courtesy Matthew Goeckner), shows a very neat and orderly approach to a simple mechanics problem.**
- **Note that there is a very concise problem statement, and the concept applicable for the solution is also stated.**
- **The theory (scientific principle that applies) is defined next, and assumptions are put down as well.**
- **Given that torque = force X lever arm, and that for balance, net torque (CW + CCW) = 0, then then solution is quite straightforward.**



Accuracy Counts Too!

- Note that as well as being neat, the problem as constructed is also accurate in terms of spelling and grammar.
- This is VERY important! As a technical professional, how do you think your supervisor will regard you if you turn in a report that is messy, inaccurate, and full of spelling and grammar errors?
- Right! He/she will look elsewhere when raise/promotion opportunities come along.
- Since neat, accurate, professional paperwork is a basic requirement in industry, you might as well start now!



Homework Set 1
8/13/2010
Page 1/1

Intro to Eng.
MECH 1108
Section 109

I.R. Student
ID 123456IRS

Set information... Class information... Student information...

3-0235- 50 sheets – 5 SQUARES
3-0236- 100 sheets – 5 SQUIRES
3-0237- 200 sheets – 5 KNIGHTS
3-0137- 200 sheets – FILLER UP

Problem 3.2 — State problem

Balance Beam: Determine the mass needed at 3 m from the fulcrum required to balance a load of 10 kg, 5 m from the fulcrum.

Concept: — State underlying concepts

For a beam to be balanced the torques around the center – or fulcrum – must be equal.

Theory: — State underlying theories

Torque is force crossed with the moment (distant) of angular movement, $\vec{\tau} = \vec{R} \otimes \vec{F}$. Thus the sum of the torques must be zero $0 = \sum \vec{\tau} = \sum \vec{R} \otimes \vec{F}$

Assumptions: — State assumptions

The beam has negligible mass

Solution:

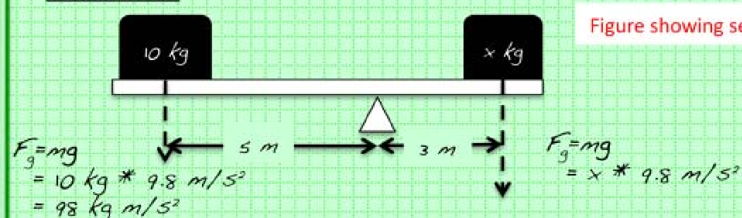


Figure showing setup

$$0 = \sum \vec{\tau} = \sum \vec{R} \otimes \vec{F}$$

$$= R_1 \otimes F_{g1} + R_{L2} \otimes F_{g2}$$

$$R_1 \otimes F_{g1} = -R_{L2} \otimes F_{g2}$$

$$5m * 98\ kg\ m/s^2 = -(-3m) * x * 9.8\ m/s^2$$

eliminating units

$$\boxed{x = \frac{50}{3}\ \text{kg}}$$

Step by step solution – noting units correctly

Solution – either boxed or underlined

Not every part is needed in every homework problem. **(For now – include each piece – marking the un-needed parts as 'not applicable' or N/A)**

Consistency check:

1) Units are correct. 2) The mass must be larger by the ratio of the distances. Thus mass 2 must be 5/3 times mass 1

Does your solution make sense? – look for stupid erros! (yes the 'r' is missing!)

Approach Methodology

- **So, we know about neatness and accuracy. What about a guideline to homework preparation in general?**
- **The idea in solving homework problems is to advance your general comprehension in the process.**
- **What this implies is that you must clearly understand the overall process from problem statement to solution.**
- **Further, it means that when you arrive at a solution, you clearly understand the technical knowledge that you used to produce the desired answer.**
- **Let's consider this approach methodology.**

Read the Problem Carefully

- Take the time to <u>fully understand the problem</u> and the desired solution. That is:
  - What information is given; what is required?
    - Is there enough information or maybe too much information?
    - What information is useful?
  - Are there clues that point to a solution? Clues might include words such as:
    - Addition: sum, full (“full diameter”).
    - Subtraction: difference, exceed, larger.
    - Multiplication: product (volume, surface area).
    - Division: Fraction, share, quotient.
  - Is there enough information to draw a picture?
    - If you have enough information, draw a diagram!

Problem Definition/Analysis

- **Carefully write down what the problem requires.**
  - **What is the final (desired) result?**
  - **Do I clearly understand the form of the answer?**
  - **Does the statement clearly lead to a possible solution?**
  - **Is the statement such that others could understand it?**
- **Analyze the problem to clarify the path to solution.**
  - **Are there similar problems in the lecture?**
  - **What makes this problem different or unique compare to problems I have seen so far?**
  - **Review, if necessary, the related lecture notes and examples.**
  - **Compare this problem to others solved in class or in text examples and determine if similar enough to help in approach.**

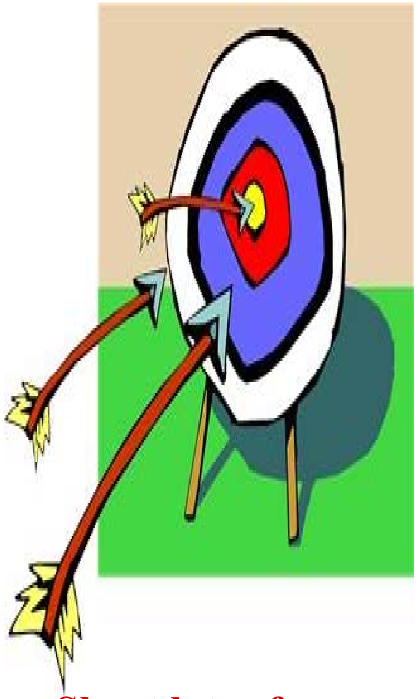
Understand the Goal

- **Write down or clearly express in your mind the goal or problem outcome.**
  - **Is the desired problem a specific type of circuit, quantity, force, value, or general equation or relation ("derivation")?**
  - **Is the desired result a physical dimension, a force solution, or some specific value, such as a velocity, mass, or current?**
  - **Is the desired answer specific or more general, such as formula for a specific quantity that can produce several answers later? Such a result might be, per our earlier example, the formula the resistance of parallel resistors, which could be applied to several problems.**

Where are we going with this problem?

Find Possible Solutions

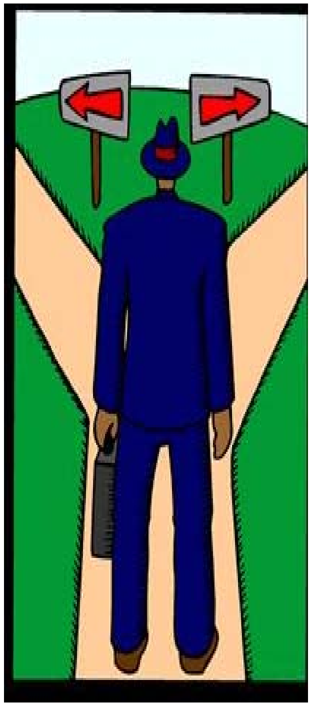
- **During this stage, generate as many possible solutions as you can. Search through class notes, the text, or other reference books.**
- **Do not worry about whether or not they are realistic, practical, or effective. A "far-out" method might, with work, be developed into a very effective solution.**
- **It can be helpful to review previous homework to search for similar problems and solutions.**
- **Be sure to write down all the possibilities you generate so that you can approach the solution systematically.**



Shoot lots of arrows at the target!

Choose an Approach/Analysis

- At this point, choose an approach and attempt to solve the problem.
- After arriving at the solution, analyze it in terms of the problem statement and the goal.
  - Is it relevant to the statement?
  - Does it meet the goal/satisfy all problem requirements?
  - Is the result <u>reasonable</u>?
    - If the result is the weight of two cubic inches of steel, the answer should NOT be a ton!
  - Do the units of the answer match what would I expect?
    - If the result is velocity, units should not be kilograms!
    - If result is power, time should be in the denominator!



"When you come to a fork in the road, take it!" (Yogi Berra)

Complete the Problem

- If the answer is "reasonable," and the solution clearly satisfies the goal of the problem, then the problem solution is more than likely correct.
- However, consider the following questions as well:
  - Can you check the result? Can you validate the answer (e.g., by answers provided in a text or answer section of notes).
  - Could you derive the result differently? If so, this might give you a power validation of your result.
  - Can you tell at a glance that the answer is appropriate? Are units reasonable, is the magnitude of the answer in-line with estimates, and do you feel "comfortable" with your result?

Summary

- **Because homework provides both visual and tactile learning reinforcement, it is a very powerful tool in learning any discipline.**
- **Homework requires a disciplined approach, NOT a quick-as-you-can, "plug and chug" approach.**
- **In general, when you can tie homework solutions directly to lecture examples, revised and rewritten class notes, or recommended approaches in the text, you are on the right track to permanent, productive technical knowledge.**

Homework Problems

- **Now, test your homework problem-solving and knowledge-building chops.**
- **On the next page are two problems. They are unique to you in that you do not have any prior knowledge of these areas particularly (unless you happen to be a hobbyist in the area or an avid reader).**
- **Solve these problems per the methodology stated, using engineering paper and very neat drawings.**
- **Homework due next period.**
- **Note that a knowledge reference is given for the problems.**

Assignment

- **Three digital logic signals (0 or 1 only) named a, b, and c are sent to a logic circuit. A certain condition of these inputs should result in a signal (logic 1) being sent out of the desired circuit to cause another circuit to turn on. This signal is only sent when a and b are 1, or when c is 1 or when both conditions are 1. Design a circuit to get this result. Reference: http://www.utd.edu/~dodge/EE2310/lec3.pdf, slides 4-11. Note: inputs and outputs are only 0's and 1's. Don't worry about voltage levels, electronics, etc. – just the logic itself per the lecture notes.**

- **In the same system as above, another circuit that is required must react when three input conditions are true (= logic 1) at once. The inputs are x, y, and z. Complete a logic solution such that when x = y = z = 1, your circuit outputs a 1 to initiate another function. Don't worry about where the 1 you generate goes – just design a circuit such that when the inputs all = 1, your circuit generates a logic 1 on its output.**