****** WEEK 12 ******

WEEK 12 - SOLIDWORKS (.7h)

12.1 SOLIDWORKS

Engineers plan out their designs down to the tiniest detail before anything is made. This helps save time and money. Nowadays design is done with sophisticated computer modeling software (CAD).

Solidworks ("SW") is a popular parametric 3D solid modeling program (used by ME's). Parts of created in 3D and the software creates technical drawings (almost automatically).

Here are some important SW features

1. 3D - parts are made in 3 dimensions
2. Parametric - **dimensions drive geometry**, allowing for **changeable** parts
3. Design intent - refers to how design behaves after a change is made.

BASIC MODES

1. Part
2. Assembly
3. Drawing

BASIC CONSTRUCTS

1. Extrudes
2. Revolves
3. Sweeps
4. Lofts

SEE SOLIDWORKS HANDOUT

12.2 Exam 4

******* WEEK 13 *******

WEEK 13 - ENGR EDUCATION (1h)

13.1 PRELIMINARIES

CT brings - gyroscope, pendulum, orbit simulation
Exam 4

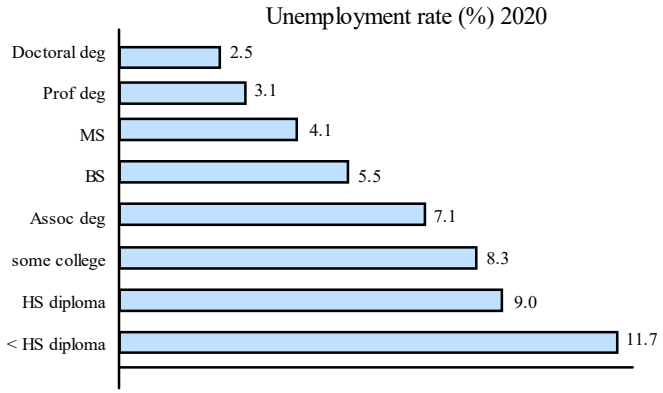
13.2 IMPORTANCE OF EDUCATION

SALARY VS. EDUCATION

Salaries typically go up with higher education

1. $37.0 K High school graduate
2. $40.2 K Some college
3. $43.5 K Associate degree
4. $61.0 K Bachelors degree
5. $72.9 K Masters degree
6. $90.6 K Doctoral degree
7. $95.5 K Professional degree

Unemployment decreases with education



13.3 DEGREE LEVELS

1. Certificate (1 - 1.5 years full time) - learn a basic technical skill (like drafting)
2. Associate degree (AA or AS) (2 yrs full time) - basic skill + general education
3. Bachelor of Science (BS) (4-5 years full time) - learn basic principles, science & math, organization, communication, and 6-8 classes in a SPECIALTY area.
4. Master of Science (MS) degree (1-2 years full time after BS) - coursework + THESIS (or research proj)
5. Doctor of Philosophy (PhD) (4-7 years after BS) - highly specialized coursework, original research, 90% of effort to research and 10% to courses

13.4 ENGINEERING VS. CTE EDUCATION

13.5 ENGINEERING UNDERGRADUATE (BS) PROGRAM

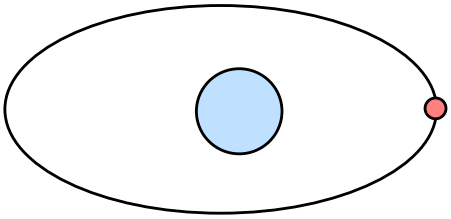
It is strongly suggested that engineering students attend an ABET-accredited university (Accreditation Board of Engineering and Technology). Engineering BS programs are comprised of:

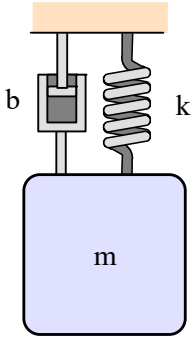
- Mostly engineering courses (of course)

- General education courses (history, economics, writing, language, social studies)
- Foundational **science** and **math** courses.

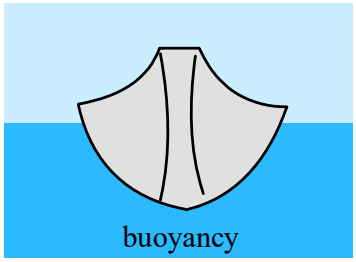
MATH & SCIENCE COURSES

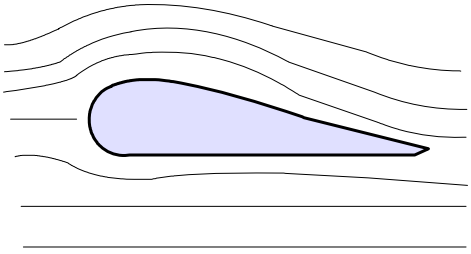
1. Chemistry (1 yr)
2. Physics (1-2 years, calculus-based) - study of how the **universe behaves**. (develop equations)
   - Newtonian physics - physics of commonly-encountered objects (ball, cars, planes, buildings)
   - Bernoulli Equation - LIFT force on airplane wings
   - Archimedes Law - buoyancy forces that keeps boats afloat
   - Electricity and magnetism - how electricity works, magnetism, circuits

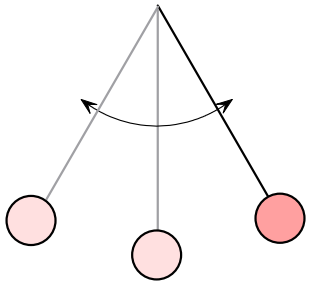

orbital mechanics



oscillations




Lift on wing (Bernoulli)


Pendulum

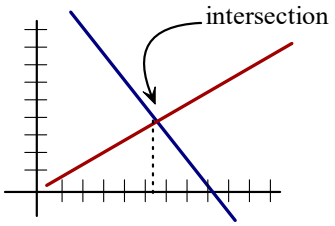
$$T = 2\pi\sqrt{\frac{L}{g}} = 2\pi\sqrt{\frac{.33\text{m}}{9.8\,\text{m/s}^2}} = 1.15\,\text{s}$$

$$T = 2\pi\sqrt{\frac{L}{g}} = 2\pi\sqrt{\frac{1\,\text{m}}{9.8\,\text{m/s}^2}} = 2.0\,\text{s}$$

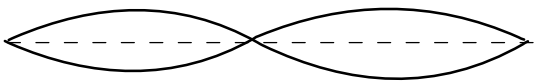
3. Mathematics (2 yrs, starting with calculus) - tool used to model, solve problems, make predictions
   - Pre-engineering math
     - algebra (math of variables), geometry (shapes, sizes), trigonometry (triangles), pre-calculus

   - Calculus (1 year) - math of MOTION and CHANGE
   - Vector calculus - calculus of many variables at once (magnetic fields, fluid flows)
   - Linear algebra - algebra of linear equations (fluid mechanics, robotics)

$$x + y = 12$$
$$x = 2y$$

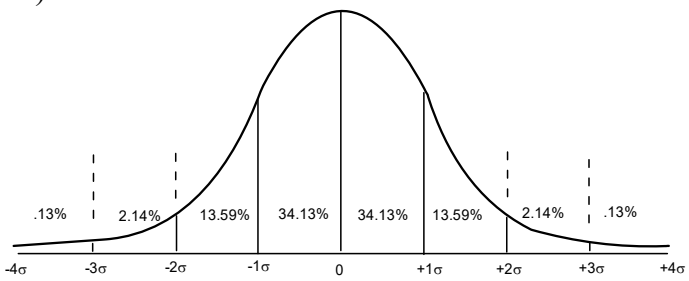


   - Differential equations
     - solving equations having a variable & its derivatives (vibrating strings, sound, light, membranes)



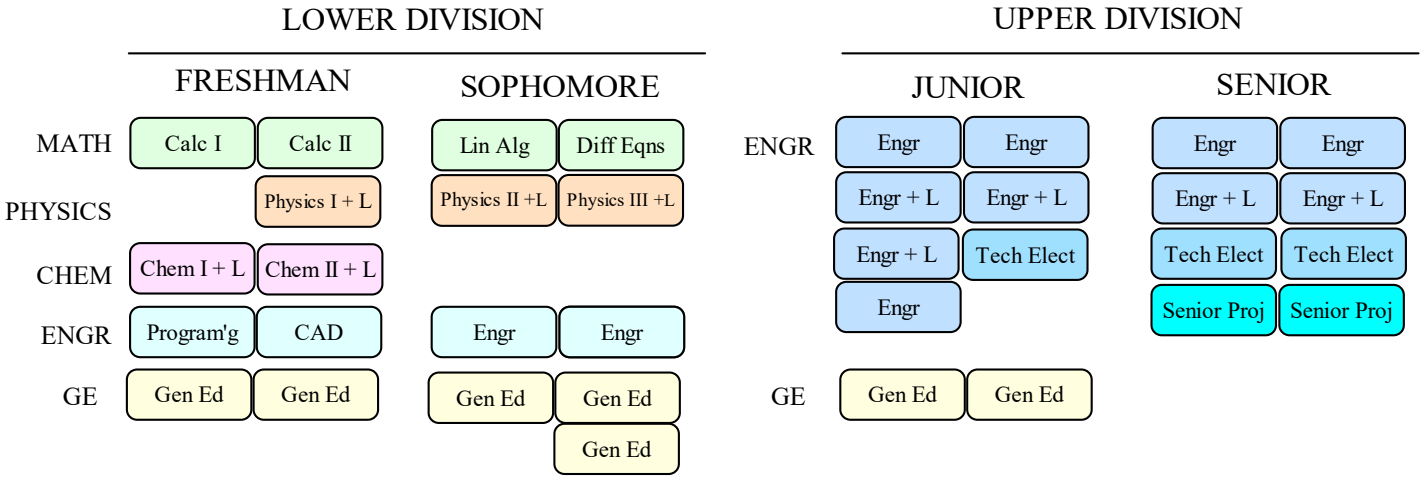
$$\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2} \text{ where } c^2 = T/\rho \text{ (wave eqn)}$$

- (Statistics - math of data collected in the real world, probability, variation (23 people in a room)



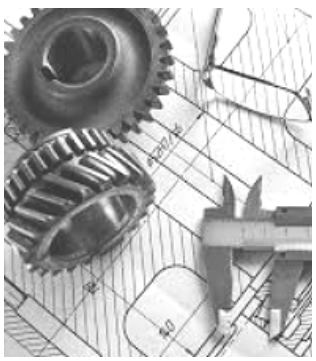
Normal, Bell-Shaped Curve

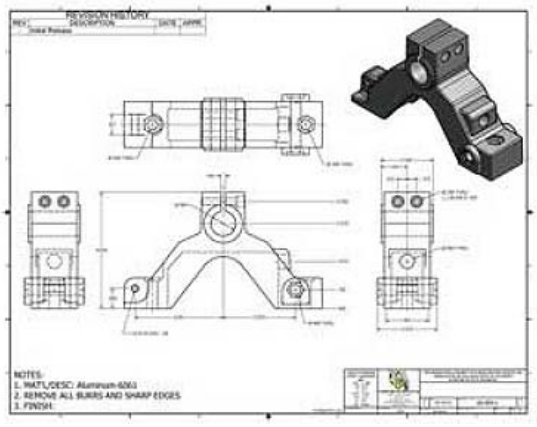
ENGINEERING COURSE PLAN (not on exam)

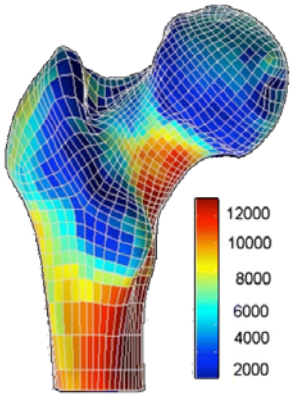


COMMON ENGINEERING COURSES (esp CE, ME, EE)

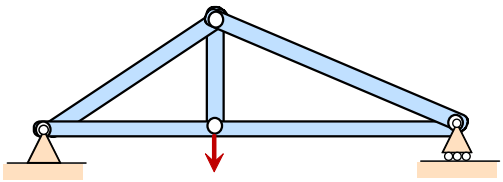
1. Drafting – use CAD (computer-aided design) & create technical drawings.
2. Finite-Element Analysis –apply virtual forces to an object & compute stresses & deflections in material

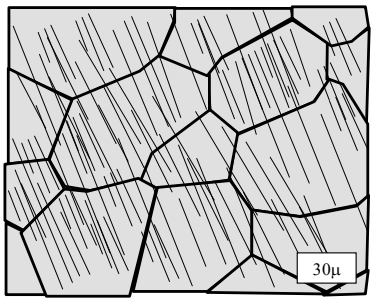




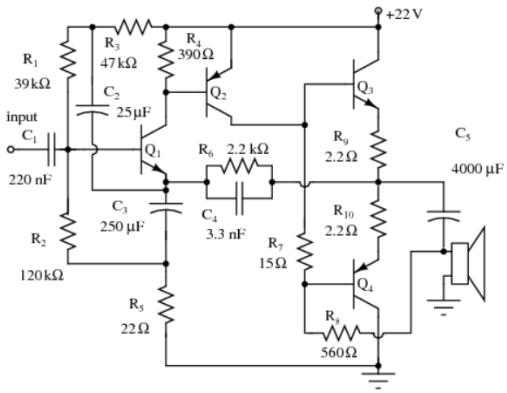


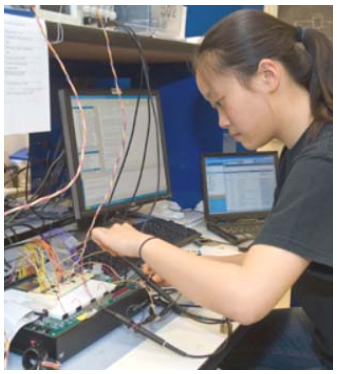
3. Computer programming – numerical methods, simulations (C++, Matlab, Fortran (before))
4. Statics - physics of things that don't move (roads, buildings, bridges)
5. Dynamics - physics of objects that move (engine parts, planes, gyroscopes)
6. Materials – strength, failure, annealing, hardening, fatigue, grains





7. Electric circuits – esp. EEs, CmpEs, MEs
8. Laboratories – hands-on experiments (not just theory), collect & analyze data.
9. Senior Design Project (~ 1 yr)
   - Design & make something. Get it to work. (not theoretical).
   - Involves teamwork, project planning, troubleshooting, etc.





13.6 Career Technical Education (CTE)

Career Technical Education (or CTE) programs teach students technical skills that allow students to obtain jobs after completing community-college level programs (that is, jobs that don't require a BS degree). For SAC Engineering, these programs include: drafting/CAD technology and engineering technology.

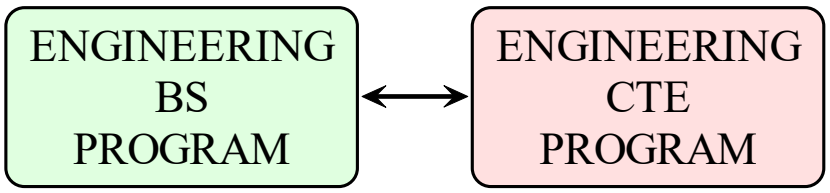
DRAFTING/CAD TECHNOLOGY

These programs prepare students to be ENGINEERING CAD DRAFTERS. Engineering drafters use CAD to create technical drawings. Engineering CAD/Drafting programs teach students how to use CAD programs and also about standard drafting practices (e.g., GD&T of mechanical drafting).

ENGINEERING TECHNOLOGY

These programs prepare students to become ENGINEERING TECHNICIANS. Engineering technicians build prototypes, do fabrication, perform testing, and collect data. They generally need to be handy (like an automobile mechanic), and they spend most of their time in the lab. Engineering technology curriculum is more applied and practical compared to engineering curriculum which tends to be more theoretical.

ENGINEERING EDUCATION (BS) VS. CTE EDUCATION



Unfortunately, there is **very little overlap** between engineering programs and engineering CTE programs.

Engineering BS programs emphasize theory and advanced concepts (using rigorous mathematics & physics). For instance you may learn how to compute the stresses and strains that form in a structure, or whether a certain control law is stable. You may learn to perform mathematical proofs or develop mathematical models for engineering problems. Much less time is spent on applications and hands-on learning (though there will be labs and a senior project). Engineering programs tend to take longer to complete. Many engineering BS grads find themselves unable to MAKE things.

Engineering CTE programs emphasize hands-on application and implementation. They tends to have much less math and science (perhaps none). The emphasis will be hands-on and practical (e.g., actually make stuff like technical drawings, or parts, etc.).

13.7 Learning & Personal Growth

Perhaps you are choosing your career now. This is a good time for self-reflection. Ask yourself what you want in life. What are your strengths and weaknesses? What are your interests?

What should you get out of school?

1. Learn to **LEARN**!
2. Learn to **THINK**!

Learning Modalities - how do we learn?

1. Visual – "learn by seeing"
2. Auditory – "learn by hearing"
3. Tactual – "learn by touching"
4. Kinesthetic – "learn by doing"

13.8 Succeeding in Engineering Education

Engineering curriculum can be quite rigorous. It is one of the hardest programs you can take at a university. However YOU CAN DO IT! Here are some tips!

1. Prioritize school (school must come first!)
2. Do your best and be on top of things (do ALL hw, attend class, read book, know your grades)
3. Don’t fall behind!
4. Manage your time
   - keep a schedule. When will you study?
   - plan on ~3-4 hours hw/studying time for ea. 1 hour of lecture (STEM majors).
   - don't procrastinate - doing things at the last second always seems to cause problems
   - be realistic... remember the "60-Hour Rule" -
     if work + school time exceeds 60 hours per week, your odds of success go way down!

13.9 LAB/TECHNICAL / PROJECT WORK

WORK ON ME PROJECT

COUNSELING VISIT? (FINANCIAL AID?)

****** WEEK 14 ******

WEEK 14 - OTHER KEY BRANCHES (.5h)

14.1 PRELIM

14.2 INDUSTRIAL ENGINEERING

DESCRIPTION

Industrial engineering involves the design of production systems - how to integrate machines, staff, materials, money, & scientific methods in order to manufacture a product. Examples of things industrial engineers (IE's) work on include factory design and industrial automation. Activities include design and layout of production facilities, maximizing work flow & space utilization, and ensuring facility efficiency and workplace safety. IE's work at manufacturing or industrial firms.

Professional society - IIE (Institute of Industrial Engineers)

SUBDISCIPLINES

1. Operations – supply chain management (managing raw materials, inventory)
2. Production (quality control, etc.)
3. Manufacturing processes & quality control
4. Ergonomics.
5. Engineering economics.

14.3 BIOMEDICAL ENGINEERING

DESCRIPTION

Biomedical engineers design products that are related to biomedical, healthcare, and other products that improve the quality of life. Examples of things worked on include implants, prosthetics, medical devices, tissue engineering, and bio-imaging (MRI, PET). Biomedical engineers work at biomedical companies including medical device, pharmaceutical, and other companies (Medtronic, Boston Scientific, Stryker, St Jude, Baxter Healthcare).

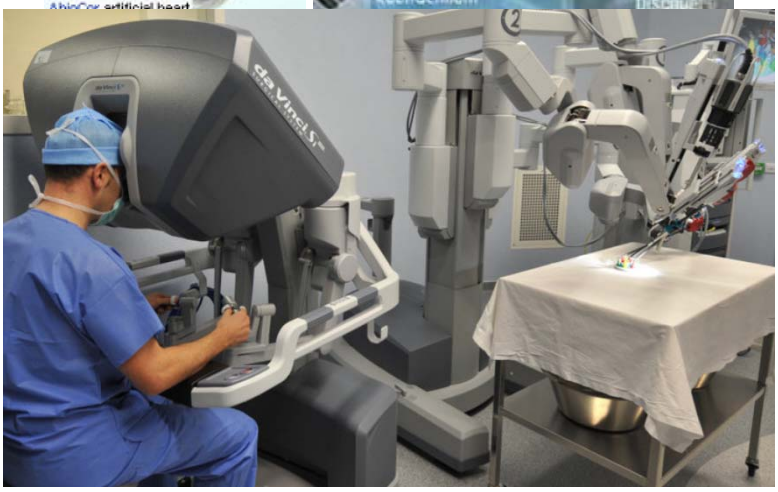
SUBDISCIPLINES

1. Biofluid mechanics – movement of blood, air in lungs.
2. Biomechanics – movement of limbs.
3. Biomaterials – for implantation, etc.

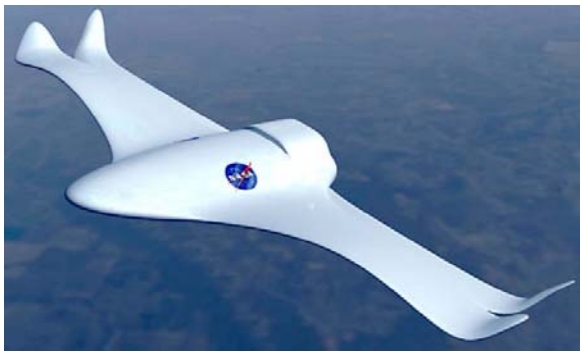
4. Sensory motor systems – nerves & muscles of human body.
5. Biomedical imaging – fMRI, PET, CT, etc.

CHALLENGES

1. Brain-computer interfaces
2. Assistive robotics (monkey/brain/robot)
3. Engineered tissues.
4. Artificial organs.
5. Robotic surgery.

14.4 AEROSPACE ENGINEERING



DESCRIPTION

Aerospace engineers design aircraft and spacecraft. Examples of their work include airplanes, rockets, satellites, and they propulsion systems. Aerospace engineers tend to have higher salaries versus other engineering fields. One reason is that an MS degree is often required. There were about 67K jobs in aerospace engineering in 2019.

SUBDISCIPLINES

1. Aerodynamics – movement of air around an object.
2. Propulsions – method of 'driving' aircraft.
3. Aircraft performance & design

4. Control systems – aircraft stability

LANDMARKS IN AEROSPACE ENGINEERING

1. Wan Hu (~1500, minor official of Ming Dynasty) – first astronaut?
2. Kitty Hawk (Wright Brothers, 1903) – first heavier-than-air flight.
3. Bell X-1 (Chuck Yeager, 1947) – speed of sound.
4. Sputnik 1 (Yuri Gagarin, 1961) – first man in space.

CHALLENGES OF AEROSPACE ENGINEERING

1. New propulsion systems
2. Reusable vehicles
3. Unmanned vehicles
4. Hypersonic flight
5. Interplanetary flight

14.5 TECHNICAL/LAB TOPICS

Work on ME project (bring progress pics)

******* WEEK 15 *******

WEEK 15 - TECHNOLOGY COSTS / BENEFITS

15.1 Benefits of Engineering & Technology

There are many benefits to a technological society. These include improved quality of life, health & well being, access to clean water, greater abundance (food, goods, services, etc.).

Food - increased agricultural yields,
Medical advancements - surgery, medicines, cures for disease
More comfortable life - machines do dangerous & difficult tasks
Easier & safer travel - planes, jets, cars, etc.

15.2 Costs of Engineering & Technology

Perhaps the biggest cost of technology is ADVERSE IMPACT TO ENVIRONMENT.
Many of the problems come from overpopulation. There are 8B people on the planet consuming too many resources (water, food, etc.), especially from richer countries.

Global climate change (global warming) - CO2 emitted when fossil fuels (oil, gas, coal) are burned. Planet is heating up - sea level rise, increases in diseases, unpredictable changes in weather patterns

Pollution (of air, water, ground) - causing ecological destruction, degrading human health
- chemicals - getting into air, water, ground
- plastics - convenient, but plastic waste is now everywhere (including inside our bodies)
- air pollution (smog) - esp in urban areas (e.g., Southern CA)
- ozone layer - ozone in upper atmosphere destroyed by CFC's (and other compounds) released into the air

Destruction of natural habitat
- de-forestation - needed for the wood and materials, and for space (to grow livestock),
- oceans - chemicals, chemical fertilizers, pesticides dumped into waters destroying the ecology

Health - more sedentary life styles, over-eating,

Warfare - more deadly (chemical, biological, nuclear weapons)

EXAM 5 REVIEW

WEEK 12 - SOLIDWORKS

Know 4 basic constructs (extrudes, revolves, sweep, lofts) - YES
Know 3 modes (part, assembly, drawing) - YES
Know what "parametric" means (dimensions drive geometry) – YES

WEEK 13 - ENGINEERING EDUCATION

Salary vs. education (overall trend) – YES.
Degrees (+ time to complete) – YES.
Undergrad programs
ABET stands for – YES.
General education – no
Technical/science courses (physics, chem.) – YES
Physics definition – YES.
Newtonian mechanics – YES.
Math – name what the following 4 (algebra, geometry, calculus, statistics) study – YES.
Sample engineering course plans & list of courses for ME, CE, EE, AeroE, CmpE– no.
Common engineering courses – name 3 of 8 listed - YES
Engineering courses & what they cover – statics, dynamics, senior project – YES
Computer programming languages – remember C and Matlab – YES.

CTE education vs. Engineering BS educations - emphasis of each, differences - YES

Leaning & Personal growth
Learning modalities – YES.
60-hour rule – YES.
How to succeed as engineering student – YES.

WEEK 14 - OTHER KEY BRANCHES

Definition of each?	YES
Stuff worked on?	YES
Sub-disciplines –	YES
Professional society –	YES
Emerging technologies –	no

WEEK 15 - ENGINEERING & TECHNOLOGY COST/BENEFITS - YES

******* WEEK 16 *******

WEEK 16 - FINAL TOPICS, ME PROJ, EX 5 (1h)

Final Topics (.5h)
ME Project Presentations (3 min/student, 1 - 1.5 h)
Exam 5 (40 min to 80 min)

16.1 Life goals and career decisions

As you select your career, ask yourself:

1. What do you want to be?
2. What problems do you want to solve?
3. What is important to you?
    1. Making a lot of $$?
    2. Time off for family?
    3. Accomplishing something big?

16.2 Succeeding (My advice...)

1. Focus on long-term goals!
2. Prioritize school – try to work less (or not at all, if possible) to focus on school.
3. Do your best in school.
4. Have a plan and stick to it.
5. Don't get behind during the semester!
6. Constantly reminder yourself: YOU CAN DO IT!

16.3 Why pursue engineering?

Engineers will play a key role in solving the problems of modern society, mankind, and our nation.

1. Overpopulation: 4.4B (1980), 5.3B (1990), 6.1B (2000), 6.9B (2010), 7.8B (2020)
2. Aging populations
3. Limited resources – energy, food, water
4. Environmental impact of technology – pollution, smog, global warming (sea level rise, weather changes, disease)

CHALLENGES OF ENGINEERING

1. Upgrade sagging US infrastructure
2. Solving problems in 3rd world countries
3. Reducing carbon footprint, increase sustainability in manufacturing, construction, etc.
4. Develop alternative, sustainable energy sources
5. Promote STEM education

6. Enhance cyber-security
7. Address climate change
8. Enhance food production
9. Improve health and well-being

IS ENGINEERING FOR YOU?

1. Designing or creating things?
2. Taking stuff apart and putting it back together?
3. Figuring out how things (machines, mechanisms, etc.) work?
4. Science and math?

16.4 Programs at SAC (see Catalog)

16.5 ME Project Demos

16.6 Exam 5