University Of California, Berkeley
Department of Mechanical Engineering

Engineering 25: Visualization for Design (2 units)

Undergraduate Required Course

Syllabus

CATALOG DESCRIPTION:

Development of 3-dimensional visualization skills for engineering design. Sketching as a tool for design communication. Presentation of 3-dimensional geometry with 2-dimensional engineering drawings. This course will introduce the use of 2-dimensional CAD on computer workstations as a major graphical analysis and design tool. A group design project is required. Teamwork and effective communication are emphasized.

COURSE PREREQUISITES:

None

TEXTBOOK(S) AND/OR OTHER REQUIRED MATERIAL:

Lieu, D.K., and Sorby, S.A., <u>Visualization, Modeling, and Graphics for Engineering Design</u>, Cengage Publishers, 2008.

A variety of good manuals on AutoCAD and Solidworks are available from the many bookstores around campus, and may be used as reference material for those with little or no CAD experience.

COURSE OBJECTIVES:

Improve 3-dimensional visualization skills; enable a student to create and understand engineering drawings; introduce 2-dimensional computer-aided geometry modeling as a visualization, design, and analysis tool; enhance critical thinking and design skills; emphasize communication skills, both written and oral; develop teamwork skills; offer experience in hands-on engineering projects; develop early abilities in identifying, formulating, and solving engineering problems; introduce students to the societal context of engineering practice.

DESIRED COURSE OUTCOMES:

Upon completion of the course, students shall be able to communicate 3-dimensional geometry effectively using sketches; operate 2-dimensional CAD software with a high degree of skill and confidence; understand and create engineering drawings; visualize 3-dimensional geometry from a series of 2-dimensional drawings.

TOPICS COVERED:

3-dimensional visualization and spatial reasoning, sketching for design communication; fundamentals of orthographic projection with applications; drawing conventions and presentation of 3-dimensional geometry on 2-dimensional media; 2-dimensional CAD including parametric drawing; reading and creating engineering drawings; engineering drawing standards.

CLASS/LABORATORY SCHEDULE:

One hour of lecture and 2 hours of laboratory per week.

Homework will be assigned in lecture each week and will be due the following week. The CAD workstations in rooms 2105 and 2107 Etcheverry Hall are provided for student use in this, and other, courses, except when a class is in session. Each student can use their CalNet ID (student ID) and their passphrase to logon to the computers Only students who are on the official class list AND have their card key activated will be allowed to login. There will be a grace period of 3 weeks from the start of the semester before students without cardkeys activation will be denied access. Most homework assignments will require the use of a computer.

The purpose of the laboratory sections is to provide a forum where students can receive assistance with lecture and homework material from the instructors and other students. At the beginning of each lab session, the GSI will usually present a short review of the week's lecture material, and provide useful hints for CAD work. The software used for this course is AutoCAD, for which the campus has a site license. Instructions for downloading the software for student's personal computers, at no cost, will be given.

A semester-long design project is required. The project is to be conducted in teams of 3-6 students. The final outcome of the project will be a working model made of materials commonly available stationary or art supply stores, a complete set of engineering working drawings, and an oral presentation. A sample project description is attached to the back of this course description.

CONTRIBUTION OF THE COURSE TO MEETING THE PROFESSIONAL COMPONENT:

Students learn graphical analysis and design techniques using the hardware and 2-dimensional software tools used by engineers in the field. Students are introduced to the concept of working in a group through the semester-long design project. As part of this project, students are required to communicate orally and graphically, and make presentations to the class and instructors.

RELATIONSHIP OF THE COURSE TO ABET PROGRAM OUTCOMES

(a) an ability to apply knowledge of mathematics, science, and engineering
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

ASSESSMENT OF STUDENT PROGRESS TOWARD COURSE OBJECTIVES:

- Weekly homework assignments 20%
- Midterm examination 20% (2 hours)
- Final examination 30% (3 hours)
- Semester project. 30%

SAMPLE OF WEEKLY AGENDA:

Week	Topic	Reading
1	Introduction to graphics and design	Lieu & Sorby Chapter 1
2	Sketching and visualization	Lieu & Sorby Chapter 2
3	Coded plans, rotation exercises	Lieu & Sorby Chapter 3
4	Cutting and reflection exercises	Lieu & Sorby Chapter 3, con’t
5	Orthogonal projection and standard views	Lieu & Sorby Chapter 10
6	Pictorial views from orthogonal views	Lieu & Sorby Chapter 12
7	2D CAD drawing	Lab notes
8	2D CAD drawing	Lab notes
9	Section views	Lieu & Sorby Chapter 13
10	Auxiliary views	Lieu & Sorby Chapter 14
11	Parametric drawing	Lieu & Sorby Chapter 6
12	Engineering drawings	Lieu & Sorby Chapter 18
13	Engineering drawings	Lieu & Sorby Chapter 18, con’t
14	Visualization from engineering drawings	Lieu & Sorby Chapter 18, con’t

HOMEWORK ASSIGNMENTS

The required textbook contains many (typically three or four dozen) exercises at the end of each chapter which can be assigned as homework. A typical homework assignment will consist of four or five exercises. Alternate, similar textbooks can be substituted for the required textbook specified above. Alternate textbooks include

Bertoline and Weibe, “Fundamentals of Graphics Communication,” McGraw-Hill publishers.

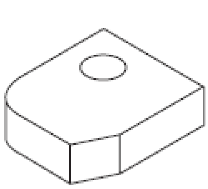
Giesecke, Mitchell and Spencer, “Engineering Graphics,” Prentice-Hall publishers.

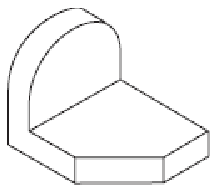
Lockhart and Johnson, “Engineering Design Communication,” Prentice-Hall publishers.

E25 Sample Homework Assignments

Week 1

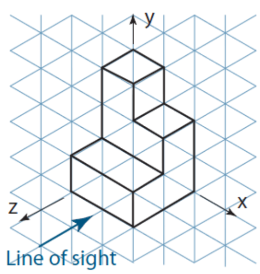
Show one or more of these objects to your partner and have your partner sketch the object(s) from memory. Repeat the process with the newly created sketch. Compare the sketch to the original object.


(a)

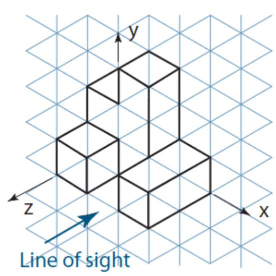

(b)

Week 2

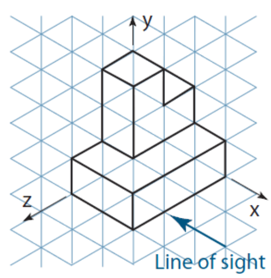
From the isometric pictorials and viewing directions defined in the following sketches, create oblique pictorial sketches that look proportionally correct.



(a)



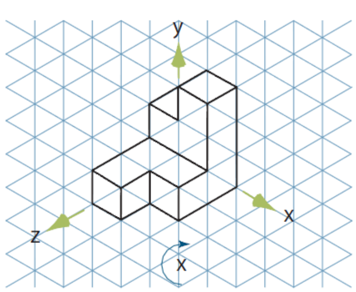
(b)

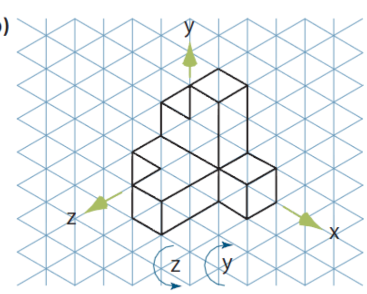


(c)

Week3

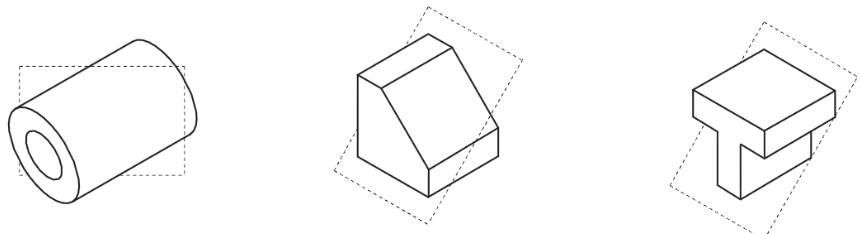
Rotate the following objects by the indicated amount and sketch the results on isometric grid paper.

(a)


(b)


Week 4

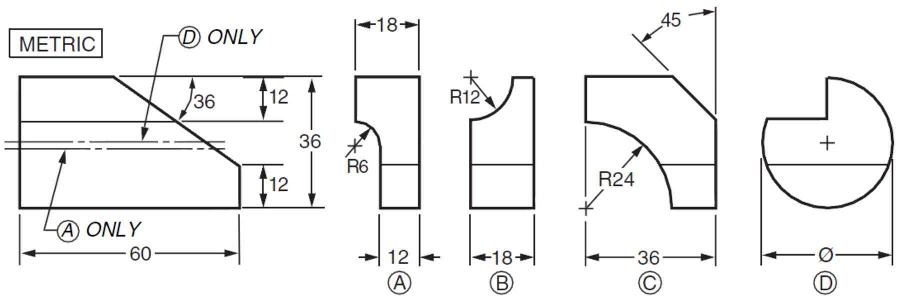
Sketch the cross section obtained between the intersection of the object and the cutting plane.



(a) (b) (c)

Week 5

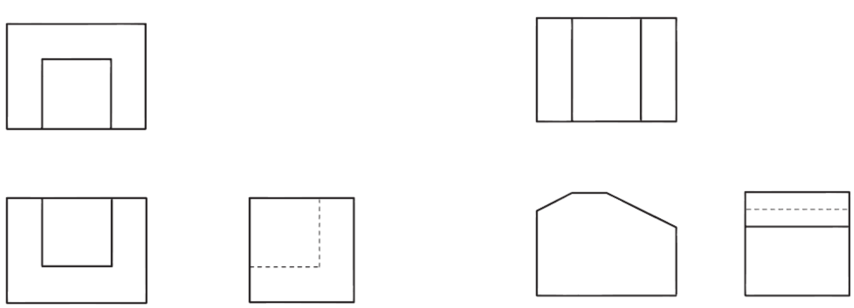
For each front view shown, draw the top view (in the correct scale, location, and orientation) that corresponds to each of the possible side views that are shown.



Week 6

Measure the features shown in the front-, top-, and right- side views of the objects shown in Figure P12.1. Using drafting instruments or CAD, create the following scaled pictorials of each object that is represented.

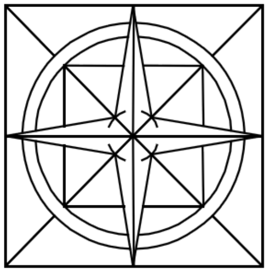
1. An isometric drawing
2. A cabinet oblique drawing
3. A cavalier oblique drawing
4. A trimetric drawing using your choice of axes angles (one axis must be vertical).
5. A two-point perspective drawing using your choice of plan location and orientation, station point, and vanishing points. The height axis must be vertical, and the two vanishing points must be on the same HL.



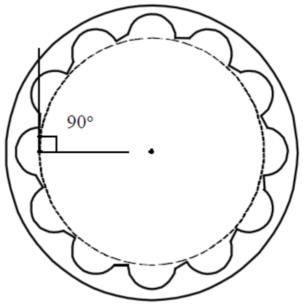
(a) (b)

Week 7

Copy these geometric patterns into CAD, and print them on a single page with approximately the same sizes shown.



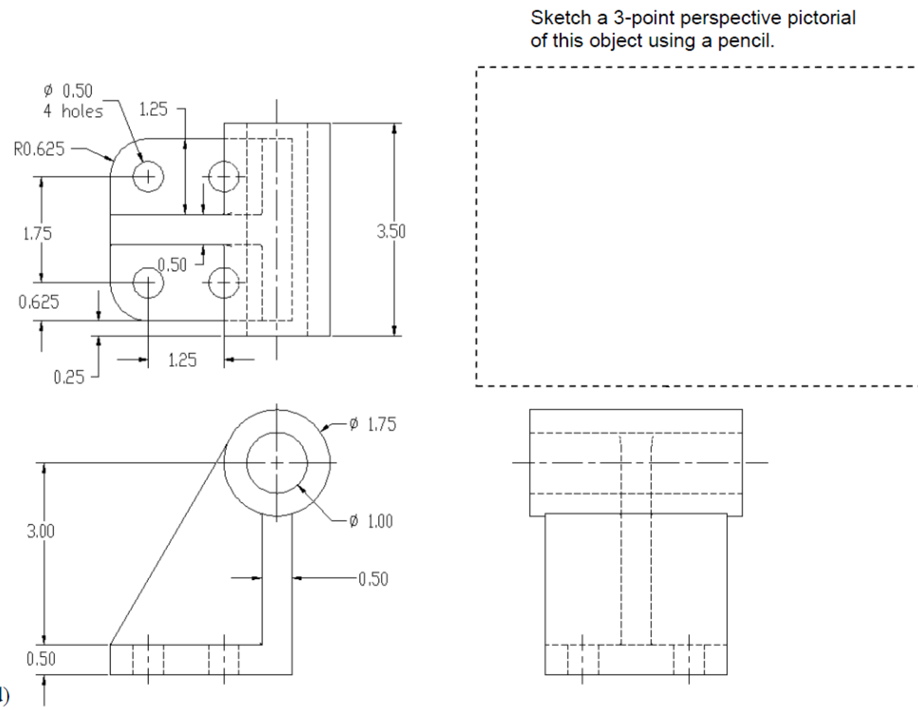
(e)



(f)

Week 8

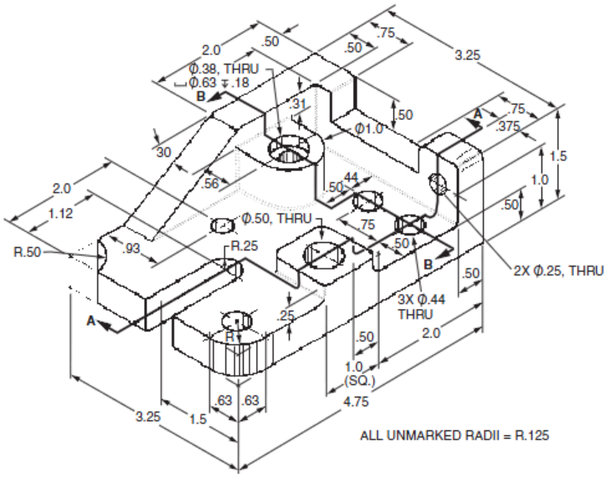
Copy these drawings into CAD, and print each of them on a single page with approximately the same sizes shown. Include with each drawing a pencil sketch of the object using the indicated pictorial type.



(d)

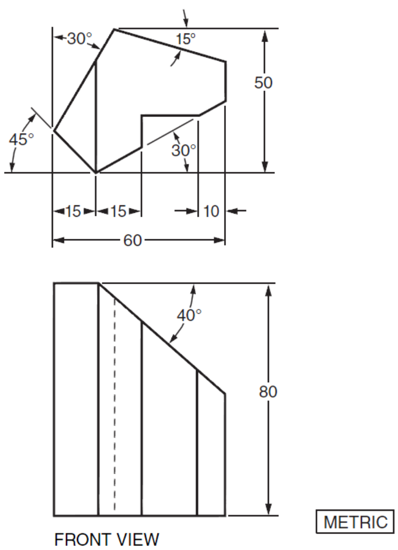
Week 9

For the object shown, create a multiview drawing to fully describe the object, including the indicated offset section views to reveal interior detail. When the precise location of the cutting plane lines for the offset sections are not specified, choose the locations to best reveal the interior detail.



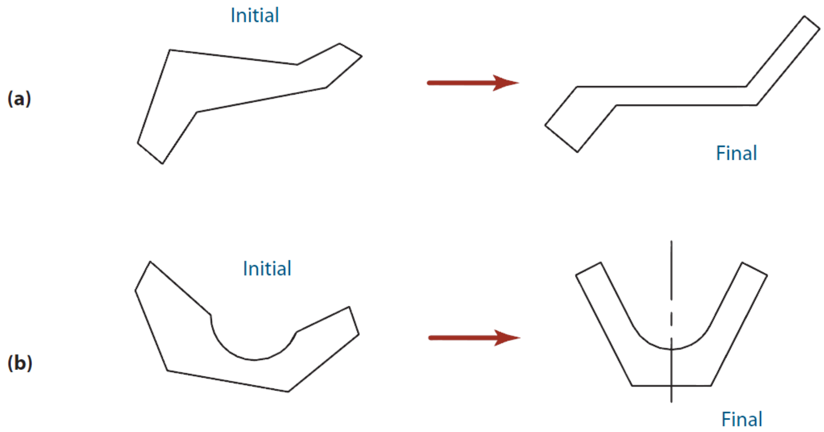
Week 10

For the multiview drawing shown, create an auxiliary view to present the entire object with the inclined surface shown in its true shape.



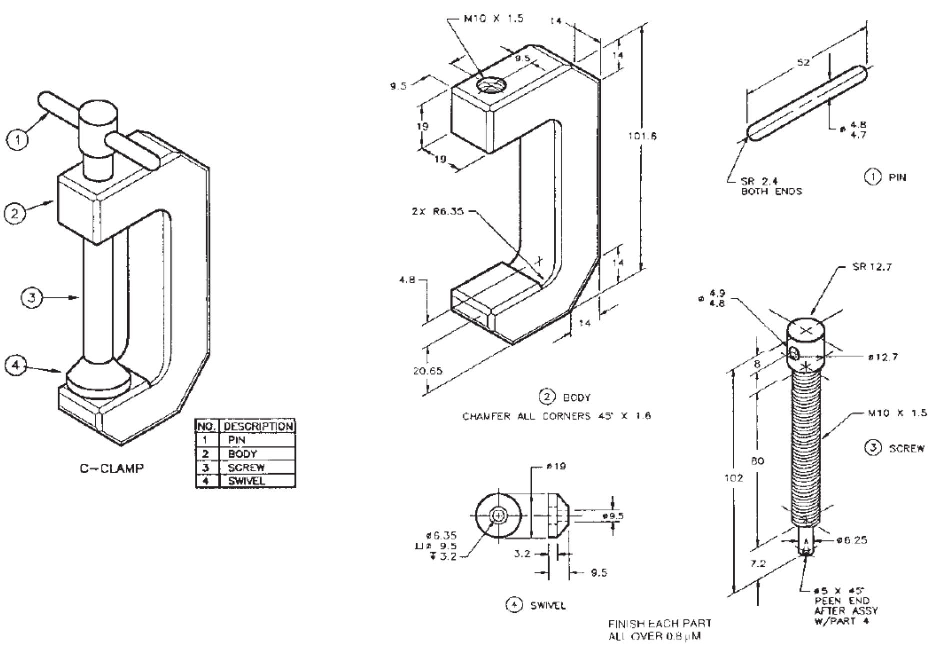
Week 11

Study the following closed-loop profiles for which geometric constraints have not been added. Number each segment of the profiles and specify the necessary geometric constraints on each segment to create the final profile. Do not over- or under-constrain the profiles.



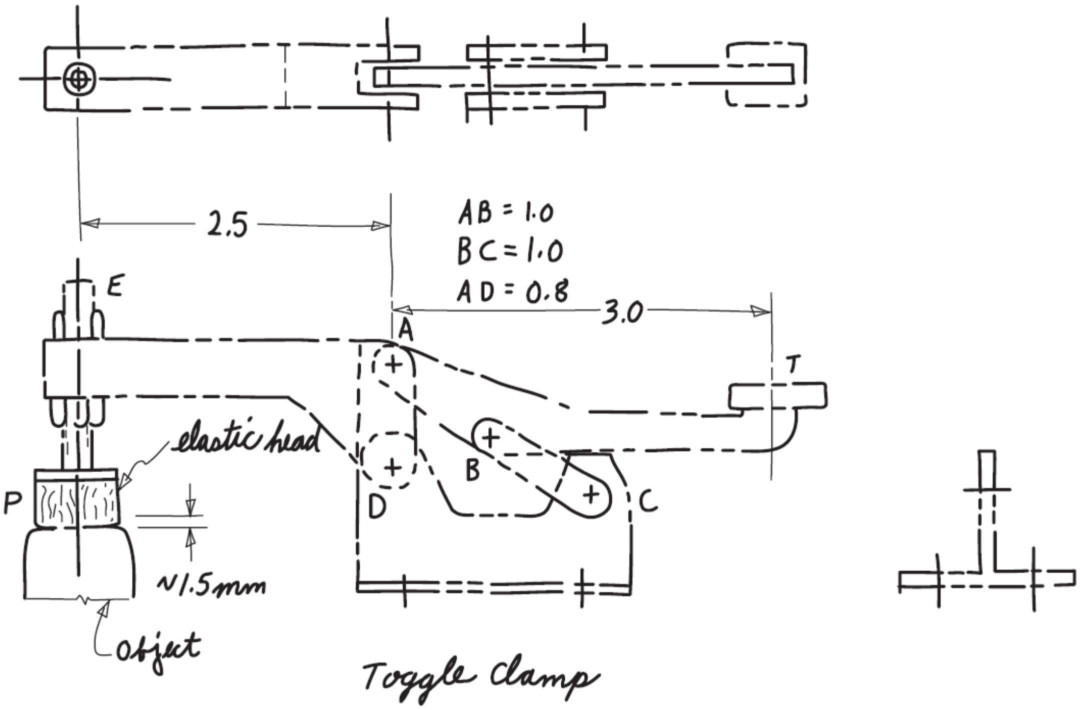
<u>Week 12</u>

The parts shown in Figure P18.1 are to be assembled into a screw clamp. Create a complete set of working drawings for the device, including an outline assembly drawing, an exploded assembly drawing, a bill of materials, and all detailed part drawings. Specify appropriate tolerances for all dimensions. All parts are made of steel. You may use metric dimensions or convert the metric dimensions to their nearest inch equivalents.



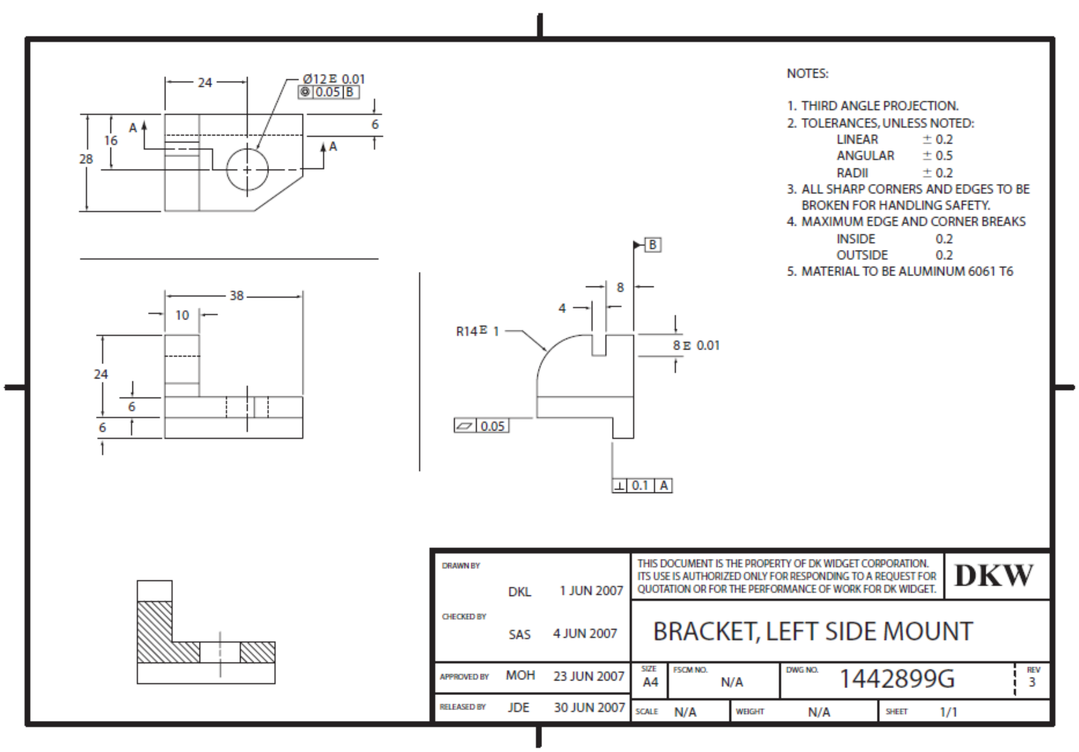
<u>Week 13</u>

A conceptual sketch of a toggle clamp is shown in Figure P18.6. Detail the design by specifying appropriate dimensions and tolerances for each part. Create a complete set of working drawings for the device, including an outline assembly drawing, an exploded assembly drawing, a bill of materials, and all detailed part drawings. All parts are made of steel. You may use the given inch dimensions or their nearest metric equivalents.



Week 14

Find the errors and poor practices in this drawing.



There 'N Back

The problem of air pollution due to personal automobiles has plagued cities worldwide for decades. Several solutions have been proposed over the years, including public mass transportation systems, electric vehicles, hybrid vehicles, low emission fuels, human powered vehicles, and even solar or wind powered vehicles. None of these have been very successful to date. Consequently, it is time to develop new concepts in powered vehicles. Recently, Caltrans received an anonymous e-mail, stating that perhaps energy in a vehicle could be stored in elastic elements. This idiotic idea was immediately adopted, and a study was commissioned to investigate the possibility of using a large number of surplus rubber bands to power a commuter vehicle.

The Mission:

Your mission is to design and build a small scale concept vehicle that will travel in a linear trajectory as far as possible, and then automatically return along the same trajectory. The device is to be powered by ~~two~~ ten rubber bands of either #62 or #64 size. The field will be the hallway on the second floor of Etcheverry Hall. A travel line will be marked with tape on the floor. Travel distances will be measured in the direction of the line only. Each team will have 3 launches of their vehicle. **The travel distance to be recorded will be the distance that the vehicle travels backward along the trajectory line, after the vehicle has stopped its forward travel.** The backward travel distance cannot exceed the forward travel distance. The single longest distance that the vehicle travels backward in 3 attempts will be recorded for each team. If the vehicle has either no forward or backward travel, the final distance will be recorded as zero.

A set of final drawings will also be due as part of the project. Teams will be organized during lab, with a maximum of 5 members per team. Cooperation and teamwork are essential. Each team will designate a leader. The instructors will communicate *only* with the team leader. This requirement forces communication and consolidation of ideas within the team. All team members will receive the same project score *except* for that portion due to "contribution to the group effort". You may not choose your own team members. Team members will be assigned by the instructors.

Design Rules:

The device must be constructed out of the following list of materials (and ***only*** the materials listed):

- Paper, 30# (maximum). 2 square meters maximum. 2 layers maximum.
- Posterboard, single ply, medium weight. 1 square meter maximum.
- Foam core modeling board, 3/16" nominal thickness. 1 square meter maximum.
- Twine, 60# (maximum) test. 3 meters length maximum.
- Wood dowel, 1/4" nominal diameter. 1 meter length maximum.
- Mailing tube, 2" (approximately) diameter, medium weight cardboard. 1 meter length maximum. No endcaps.
- Rubber bands (sample to be supplied), #62 or #64. 10 maximum.
- "Elmer's Glue-All" glue. 30 cc maximum.
- Hot melt adhesive (polyolefin). 30 cc maximum.
- "Scotch" transparent tape, ¾" wide. 1 meter maximum

All of the materials can be purchased at local art supply or convenience stores. Samples of the above materials will be displayed in the labs. Equivalent material may be substituted only with the permission of the instructor. Paints, markers, flags and other decorative items not on the list may be used as long as they are purely decorative, i.e. paint cannot be used as weight or ballast. Any design deemed by the instructors as unsafe will not be acceptable (i.e. no sharp flying objects, no explosive devices, no burning or combustible materials).

More Contest Rules:

The vehicle must be entirely self-contained, e.g. no external launching or guidance devices are permitted.

The entire vehicle must initially fit entirely within a 1.0m x 1.0m x 1.0m volume without external support. After launching, the vehicle may not expand in size or expel any parts.

The vehicle can be released by hand, or remotely triggered. Any number of team members may be involved with the release. Once release, the vehicle may not be touched.

The device must be set up within 3 minutes for each launch, or a 0.5 meter distance penalty on the total distance will be assessed for every 10 seconds overtime.

The vehicle, or a part of the vehicle, must remain in contact with the ground at all times.

Human power may be used to trigger the vehicle, but not to impart motion to the vehicle, i.e. no pushing or pulling on the vehicle. However human power may be used to store energy into the rubber bands for any use.

Gravity cannot be used to produce motion, i.e. no launching from a ramp.

Travel distance is measured in the direction parallel to the length of the hallway on the second floor of Etcheverry Hall, immediately outside the CAD laboratories. If the vehicle hits the side wall of the hallway and stops, the vehicle will be considered as stopped.

The final recorded travel distance will be the distance from the closest point of forward travel (from the starting line) on the vehicle to the closest point of return travel (from the forward mark) on the vehicle.

Spare parts are recommended, and do not count in the material inventory of the final assembly.

Required Drawings:

1. Conceptual Sketches - alternate and final designs.

2. Outline Assembly Drawings -

   Multi-view of assembled project
   Isometric or pictorial view of the assembled project.
   Cut-away views as required for clarity
   Sectional views as required for clarity
   Overall dimensions only
   Balloons to identify subassembly numbers or part numbers, and names

3. Detail Drawings - One multi-view drawing per part (isometric or pictorial required)

All dimensions
Quantity
Material
Sectional views as required for clarity
Isometric views as required for clarity.

4. Bill-of-Materials - List of all parts by PN, showing name, quantity, and material.
List of all materials needed for assembly, e.g. tape, glue.

Use millimeter dimensions. Use proper title blocks and borders for engineering drawings. It is recommended that all drawings be cross-checked by different people. Alternate the functions of drafter, designer and checker. Final approval must be made by the team leader.

Design Reviews:

Project teams will be assigned the week following the first midterm examination. A set of conceptual sketches (one set per team) for a proposed final design will be due one week thereafter. There will be a project review the week following the second midterm examination. Both of these reviews will be scored as a homework assignment, with each team member receiving the same score.

Final Demonstration and Oral Presentation:

Each team is expected to give an informative 10 minute final presentation of its design, as well as a demonstration during the distance contest. Use descriptive graphical overhead slides to complement the presentation. Keep it short and direct.

Written Evaluation (Required):

Each student in the group is required to submit a confidential evaluation of the performance and relative contribution of each of the other members of the group, as well as that for him/herself. This evaluation will be used as the main basis for assigning points for "contribution to the group effort". At the end of the course, each student will be asked to assign up to 20 points to his/her other team members based upon their relative contributions. If everyone on the team contributed equally, then each person should receive 20 points. A person who did nothing should receive 0 points. The evaluation is a very serious part of the overall course grade. In the past, students have dropped an entire grade in the course due to a poor evaluation from their team members. **Contribute to your group effort!!!**

Scoring:

Every member of the team will receive the same project score, except for the 20% based upon contribution.

20 points	Function, performance, and reliability of the machine. (GSI grade)
20 points	Design creativity and presentation. (GSI grade)
20 points	Perceived contribution to the group effort. (Peer evaluations)
40 points	Accuracy and completeness of working drawings. (Prof. grade)

Good luck and have fun!!!

E25 Sample Project Final Scoresheet - For reference only, to be completed by the instructor

Team Name ______________________________ Team Leader ______________________________

Section # ___________

Creativity, function, workmanship, presentation
from Presentation Scoresheet (40) _____

Outline Assembly (5) _____

Details (10) _____

Dimensions (10) _____

Material List (5) _____

Headers(5) _____

Overall clarity (5) _____

Total Drawings (40) _____

Individual Scores (20)

Student	Contribution	Total Project
______________________	__________	__________
______________________	__________	__________
______________________	__________	__________
______________________	__________	__________
______________________	__________	__________
______________________	__________	__________

E25 Sample Project Presentation Scoresheet - For reference only, to be completed by GSI

Team Name ______________________________ Team Leader ______________________________

Section # _____________ GSI ________________________________

Function and Reliability (10)

Total Distance: ________

Distance Penalties:

Specify:

_____ Graded on distance relative to the rest of the class. Top 25% of entire class, 10 points. Next 25%, 7 points. Next 25%, 4 points. Lowest 25%, 1 point.

Creativity (10) _____

Workmanship (10) _____

Presentation (10) _____

Total, Presentation and Demonstration _________

PERSON(S) WHO PREPARED THIS DESCRIPTION

Dennis K. Lieu and Sara McMains
7 April 2014

ABBREVIATED TRANSCRIPT TITLE (19 SPACES MAXIMUM): VIS FOR DES
TIE CODE: LABS
GRADING: Letter
SEMESTER OFFERED: Fall and Spring
COURSES THAT WILL RESTRICT CREDIT: Students who have taken E10 and E28 will not receive credit for this course.
INSTRUCTORS: Dennis K, Lieu, Sara McMains, Ken Youssefi, George Anwar
DURATION OF COURSE: 14 weeks
EST. TOTAL NUMBER OF REQUIRED HRS OF STUDENT WORK PER WEEK: 6
IS COURSE REPEATABLE FOR CREDIT? No
CROSSLIST: None