ARCH 2230 Structures 1: Statics  
Fall 2010 – Course Syllabus

"Do people think that because we are engineers, beauty plays no part in what we build, that if we aim for the solid and lasting, that we don’t at the same time do our utmost to achieve elegance? Are actual conditions of strength not always compatible with the hidden conditions of harmony?"

-Gustave Eiffel, in response to protesting Paris artists

Faculty
Erkin Ozay, AIA, lecturer
E-mail: e.ozay@neu.edu
Office hours: Tue & Fri, 11.40 am, by appointment

Time and Location
Section 1 (10203): Tue & Fri 8.00 am – 9.40 am  Snell Library 035
Section 2 (10690): Tue & Fri 9.50 am – 11.30 am  Behrakis 310

Prerequisites
Satisfactory completion of undergraduate level PHYS 1151 and undergraduate level MATH 1341 with a minimum grade of D- for each course is required. If it is discovered that you have not completed these prerequisites, you may be removed from the course at any time during the semester as per university policy and deadlines.

Course Content and Goals
This course seeks to introduce the fundamental concepts of structural design for architecture and building construction. You are expected to develop a clear understanding of the nature of forces and loads, their effects on structures as well as common structural systems and the individual and interdependent components that constitute them.

One of the primary goals of an architect, in close collaboration with the structural engineer, is to evaluate, refine and specify efficient and economical structural systems that are applicable for a certain building. Such collaboration is fruitful only if the architect has a good understanding of the engineering concepts, terms and language to achieve maximum integration of structure with other systems that, in turn, make up the architecture. The following are some of the principal goals of this course:

- Understand nature of forces, their effects on structures and conditions of equilibrium.
- Learn to analyze components and the whole of a structural configuration.
- Develop an understanding of basic structural elements and their behavior.
- Understand basics of shaping and sizing of structural components and connection details.

Subject Sequence
The first half of the semester will focus on principles of statics such as forces and moments, equilibrium, reactions as well as basic structural elements such as beams, trusses, frames and arches. In the second half
of the course we will delve into concepts of load paths, strength of materials, internal forces and basic structural design including examples on basic component sizing for some commonly used structural systems. Method of analysis will be primarily algebraic; however, some graphic analysis examples and assignments will be given as well.

Please see attached provisional schedule. The schedule will be revised and reissued periodically at my discretion throughout the semester to reflect class progress. You are required to keep up with any schedule changes communicated during the class and/or via Blackboard.

**NAAB Student Performance Criteria**

This course meets the following NAAB Student Performance Criteria to the extent designated in 2009 Conditions for Accreditation document:

“B.9 Structural Systems: Understanding of the basic principles of structural behavior in withstanding gravity and lateral forces and the evolution, range, and appropriate application of contemporary structural systems.”

Per the same document “understanding” is defined as “the capacity to classify, compare, summarize, explain and/or interpret information.”

**Completion Requirements**

Your final grade will be calculated as a composite of the following criteria:

- Class participation: 10%
- Quizzes: 35%
- Homework: 25%
- Projects: 30%
- Extra credit: May be available at instructor’s discretion

**Class participation:** Active dialogue and discussion is required. You may be asked to help solve problems at the board, suggest methods of analysis, interpret results, discuss how findings would affect your approach to a design problem, etc.

**Quizzes:** There will be 8 quizzes based on all material completed up to that session and all lecture material delivered in class up to the time of the quiz. The quizzes will be open-book so you may bring your textbook and notebook for reference. If you are absent without an acceptable excuse (as per school policy) you will fail the quiz for that meeting time. If you are absent due to an acceptable reason, the quiz will not count toward your average. In either case, there are no make-up quizzes. I will try to review each quiz question at the beginning of the next class as time permits or issue the solution on Blackboard.

**Homework:** Unless otherwise agreed upon, homework will be due the next session following the class in which it was issued. Work will be reviewed cursorily and graded in the following manner: 5(extra credit), 4 (full credit), 3 (submitted with major problems), 0 (not submitted). A late submission will be degraded a point for each day it is late. It is your responsibility to scan and e-mail your homework to me if you haven’t handed it in during class. You can work with your classmates; however, your submission should show your individual understanding and solution for the problems. I will issue solutions for the homework within the following week of your submission. If a particular problem is deemed especially difficult by the students, I will solve and explain it during class. So please speak up!

**Team projects:** There will be three team projects. I will assign team members depending on your progress throughout the semester. Submission requirements will be specific to the projects. You may be asked to present your project verbally to test your understanding which may affect your grade for that project.
Bibliography
Required textbook: Onouye, B., & Kane, K., Statics and Strength of Materials for Architecture and Building Construction
Schodek, D., & Bechtold, M., Structures
Zalewski, W., & Allen, E., Shaping Structures: Statics
Allen, E., & Zalewski, W., Form and Forces: Designing Efficient, Expressive Structures
Salvadori, M., Why Buildings Stand Up: The Strength of Architecture
Denny, M., Super Structures: The Science of Bridges, Buildings, Dams, and Other Feats of Engineering
Macdonald, A., Structure & Architecture
Gordon, J.E., Structures: Or Why Things Don’t Fall Down

Other Required Materials
You are required to bring a scientific calculator to each class. You also need to have a small 30-60 triangle or a rolling ruler for graphic analysis exercises. You are encouraged to use this tool as much as possible throughout the semester for the sake of neatness as you draw your diagrams.

Neatness
Clarity and proper formatting is a professional requirement for architectural and engineering professions. Hence, neatness, legibility and cleanliness are required for and will be part of the grading for all work submitted by you including quizzes, homework and projects. All homework needs to be completed in pencil (unless it is drafted in CAD) on graph paper. You may choose to use engineering graph paper (available from office supply stores), create your own or print copies of the PDF file that I will supply to you for use in this class. All multiple page submissions shall be stapled together.

Class Notes
You are responsible to attend classes and take your own notes. I will not distribute my teaching notes. I will however post the slideshows, assignments etc on Blackboard as required. Writing and drafting during class allows you to think through the problems and help build a memory for the concepts being discussed. If you miss a class, please make sure to get a copy of the class notes from your classmates.

Attendance Policy
Four unexcused absences will drop your grade by one letter grade, e.g. from an A to a B. Late attendance will be tracked and for every two sessions you are late to class, your participation points will be decreased by 20%. If you miss a class for any reason, it is your responsibility to get a copy of the notes from your classmates and do the catch up work. Excusable absences are as follows per university policy: Participation in athletics, participation in student activities, illness or personal crisis, religious observances, jury duty and military service. All of these conditions except the religious observances require documentation. Please contact College Student Services Office for details on what forms of documentation are acceptable and how it should be submitted. For religious observances please notify me as early as you can.

Grade Dispute Policy
Your final grade is not negotiable. I will make every effort to make sure grading is fair to everyone. If you believe that there is a legitimate problem with your grade on a specific assignment or a quiz, please e-mail me a scanned copy of your returned work and I will make a decision on whether it needs to be reviewed again. You are not allowed to bring up personal grade issues during class.

Advice
- Attend all sessions,
- Study in groups and learn from each other,
- Make sure to review and solve more example problems from other textbooks, some of which are listed above,
- Studies show that writing and rewriting class notes help immensely with learning.
Students with Disabilities
The University is committed to compliance with the Americans with Disabilities Act. If you anticipate issues related to the format or requirements of this course, please notify me. If you determine that formal, disability-related accommodations are necessary, it is important that you be registered with the Disability Resource Center (617-373-2675; www.drc.neu.edu) and notify me of your eligibility for reasonable accommodations.

Academic Integrity and Honesty
You are expected to be fully aware and compliant of the University’s Academic Integrity Policy:
http://www.northeastern.edu/osccr/academichonesty.html

School of Architecture Grading Guidelines for Lecture Classes
  A exemplary quality work. The student:
  - demonstrates one of the best performances on exams/quizzes/papers/projects the instructor has seen at Northeastern or any other accredited school of architecture
  - demonstrates a superior understanding of course readings and lectures
  - participates in class discussions cogently and willingly
  A- high quality work. The student:
  - demonstrates one of the best performances on exams/quizzes/papers/projects within the class
  - demonstrates a high level of understanding of course readings and lectures
  - participates in class discussions intelligently and willingly
  B+ good quality work. The student:
  - demonstrates strong performance on exams/quizzes/papers/projects
  - demonstrates a good understanding of course readings and lectures
  - participates in class discussions intelligently
  B above average work. The student:
  - demonstrates above average performance on exams/quizzes/papers/projects
  - demonstrates an above average understanding of course readings and lectures
  - participates in class discussions when asked to respond
  B- average work. The student:
  - demonstrates average performance on exams/quizzes/papers/projects
  - demonstrates an average understanding of course readings and lectures
  - meets attendance requirements
  C+ below average work. The student:
  - demonstrates below average performance on exams/quizzes/papers/projects
  - demonstrates a below average understanding of course readings and lectures
  - meets attendance requirements
  C well below average work. The student:
  - demonstrates well below average performance on exams/quizzes/papers/projects
  - demonstrates a well below average understanding of course readings and lectures
  - engages in excuse-making, tardiness, and absence
  C- minimal work. The student:
  - demonstrates minimal performance on exams/quizzes/papers/projects
  - demonstrates a minimal understanding of course readings and lectures
  - engages in chronic excuse-making, tardiness, and absence
  D+, D, D- marginally acceptable work. The student:
  - demonstrates unacceptable performance on exams/quizzes/papers/projects
  - demonstrates an unacceptable understanding of course readings and lectures
  - engages in chronic excuse-making, tardiness, and absence
## ARCH 2230 Structures 1: Statics
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ARCH 2230 Structures 1: Statics
Fall 2010 – Project 1: “Truss Spotting”

Date assigned
October 8, 2010

Due Date
October 23, 2010, 2.00 pm

Task
In teams of three, you will find and document different structural elements while on a walking tour of the city. You may choose to walk from Northeastern Campus to MIT Campus. Many of the following structural elements are present along this route. You need to find examples of the following structural elements:

1- Axially loaded members in tension, such as hangers, suspension cables etc.
2- Axially loaded members in compression, such as columns etc.
3- Beams and cantilevered beams
4- Planar and spatial trusses (in a roof, bridge etc.)
5- Arches
6- Rigid frames (concrete or steel)
7- Thin shells and slabs

Format
A single PDF document submitted electronically in a proper sequence as a slideshow. Resolution should be adjusted for on-screen viewing, i.e. no more than 100 dpi for images. It is your responsibility to ensure your file is small enough to e-mail, ideally no more than 8MB. If your file is too big to e-mail, please send it via a free large format delivery service such as yousendit.com for me to download. No FTP submissions.

Assume that your project will be presented as a slideshow and your document format should match the mode of presentation: use adequate size fonts, size your images properly, concise narrative etc.

Each submission should have the following components.

- Cover page: invent a title for your project, list names of team members, date of your walk and a picture of all team members in front of one of the structures in your project.
- Brief introduction page, explaining the purpose of your visit, whether there were other criteria you set for yourselves etc.
- Map of your route on an aerial photo with locations of each of your selected structures indicated.
- Table of contents page.
- 7 pages (one per each concept): Include min 2 different examples for each of the 7 concepts. Pick one of the examples for each of the concepts and detail it further. How does this specific element receive and transfer loads? What are the boundary (support) conditions? What are the approximate span, structural bay dimensions, depth and width of the member? What are the connection details? You may use hand sketches (highly encouraged), detail photos, annotated photos (dimensions noted on photos etc) and short narrative text to explain how you think this structural element works.
- One page per each student explaining how this exercise benefited you, whether you discovered something new that is of immediate use for your design process, how can the exercise be made better? This page can include visual material as well.

Grading Criteria
Your project will be graded using a 100 point base grade. All team members will receive the same 90% of the group base grade barring unusual circumstances. The last 10% will be based on your individual page.

- Timeliness: Submission past 2.00 pm will reduce your base grade to 90, an October 24th submission will reduce your base grade to 80 and further 10 point reduction for each late day following thereafter.
- Format: Professionalism, neatness, graphics, clarity as always…
- Content: The idea is for you to explore and discover. You may not get everything right explaining a structural component, but it is important for you to try and make an ambitious attempt to “speculate intelligently.”
- You may need to fill in some theoretical gaps in your knowledge by reading the later chapters of your textbook (Load Tracing Chapter) as well as other books including the ones listed in your syllabus.
ARCH 2230 Structures 1: Statics
Fall 2010 – Project 2: Power Station Structure

Date assigned
October 22, 2010

Due Date
November 6, 2010, 2.00 pm

Object of Survey
Designed by William G. Preston and built from 1889 to 1892, the West End Street Railway Central Power Station was, at the time, the largest privately-owned electric generation plant in the world and served to power the company’s electric trolley cars which ran all over the city of Boston. After 1899 the station supplied power to the Boston Elevated Railway and its final incarnation was as a maintenance facility. After being abandoned for many years and falling into disrepair, the Power Station building was purchased by a private company in 1998 and the structure underwent a thorough restoration. Currently the building is used for parking on a daily basis but it also houses temporary events such as concerts, farmers’ and artists’ markets as part of the SoWa Arts District.

Task
In teams of four, you will survey and document structural components that make up the structure. Assume you are an architectural team who will be proposing a subsequent retrofitting project and this is your existing structure report to be presented to the client. In these reports there are repeating elements in each page such as name of firm, document title, page title, numeric and graphic scale, page numbers, date etc. Each of the following should be organized on one 11x17 page to make up a professional report.

Page 1: Title page with a photograph of the structure.
Page 2: Table of contents and intro explaining, in narrative form, what the major structural components are, how the structure is configured and how it supports the roof loads.
Page 3: Approximate framing plan with a dimensioned structural grid, showing all major roof members, columns, walls and wall openings. Assign a label to each specific type of truss (T-1, T-2 etc) and each beam (B-1, B-2 etc).
Page 4: Elevations of each specific member with its loading condition shown as distributed loads (lb/ft) or point loads, with magnitudes. Also note how much load is transferred to the next structural member in hierarchy through supports.
Page 5: Plan detail and partial elevation of a typical column. Make a chart with each of the columns named per their location on the structural grid A1, A2 etc with how much load is transferred to the foundation by each.
Page 6: Draw basic elevations of the two typical facades. Explain graphically and in narrative form how the forces are transferred through the walls and around the openings for each of the typical cases. How does the form of the wall correspond to the structure within?
Page 7: 2 additional connection details, components or features of your choice documented with a photograph and a sketch along with an explanation of how you think these specific elements function structurally.
Page 8: One page per each student on how this exercise benefited you, how it can be made better and whether you discovered something new that is helpful for your design process. You are strongly encouraged to include visual material on this page. The layout of your page should be consistent with the format of your document.

Assume for your calculations: Snow load: 25 psf - Dead Loads: Slate roof tiles: 10 psf Douglas fir planking: 5 psf. For steel members use the charts at the back of your book to find similarly sized members or use 490 pcf density and approximately calculate the weight of trusses, beams and columns.

Format
A single PDF document submitted electronically in a proper sequence. It is your responsibility to ensure your file is small enough to e-mail, ideally no more than 8MB. If your file is too big to e-mail, please send it via a free large format delivery service such as yousendit.com for me to download. I may print a portion of your documents on a black and white 11x17 printer to for grading etc. I may also show some of your work in the class.

Grading Criteria
Your project will be graded using a 100 point base grade. All team members will receive the same 90% of the group base grade barring unusual circumstances. The last 10% will be based on your individual page and participation.

- Timeliness: Submission past 2.00 pm will reduce your base grade to 90, an November 10th submission will reduce your base grade to 80 and further 10 point reduction for each late day following thereafter.
- Format: Professionalism, neatness, graphics, clartity as always…
- Content: The idea is for you to explore and discover. You may not get everything right explaining a structural component, but it is important for you to try and make an ambitious attempt to “speculate intelligently.”
ARCH 2230 Structures 1: Statics
Fall 2010 – Project 3: Missing Column

Date assigned: November 5, 2010  Due Date: November 20, 2010, 5.00 pm

Object of Survey
During the schematic design stage, architects are supposed to make informed predictions about the sizes of structural components. One can rely on experience with similar components in previous projects, comparable buildings, and rules of thumb to start a productive conversation with the structural engineer. None of these predictions or decisions is made in an isolated manner. We take into consideration factors such as mechanical systems, efficiency, as well as the structural expression.

Task
You are the project team for the design of a small office building. Please refer to the attached schematic framing plan and section. The following are given:

- Building is a 4-story free standing structure.
- It will have a detached masonry core at back. Connections between the steel structure and the core will be detailed in such a way that the core only picks up lateral forces.
- At the first floor of the building Owner wants to have a column free zone in the center by eliminating one column from the grid. It is decided that although the span is relatively small, a custom steel truss will be used to span this 48' bay using wide flange members.
- Assume the following: Roof LL: 25 psf, Floor LL: 50 psf, Concrete density: 150 pcf, Steel decking average: 5 psf.
- Dead loads will be calculated by you. For columns, beams and girders use rules of thumb as well as W sections per the list at the back of your book.
- The structure is “flush framed”, i.e. top of beams and girders are aligned.

You are preparing a report for a kick off meeting with the structural engineer. The focus is on the overall structure as well as the transfer truss. The principal in charge of your office directed you to ensure the exterior expression of the building matches the structure as closely as possible. The structure within the building will be exposed. Hence you are trying to get a sense of the structural component sizes early. Your task breakdown is as follows in order:

1- Size columns, girders and steel decking and the floors per rule of thumb examples. Note that roof loads are generally much lighter and they generally don’t receive any concrete topping. Your selection for the beams and girders should be made accordingly. Rule of thumb concepts for beams and girders give you a sense of the depth of these components. Business/office functions are considered as relatively light load functions. However, for the floors select your beams and girders from the middle range of the sizes that are available to you.

2- Size columns. For this purpose use the file named “factored nominal strength of columns”. For your purposes KL will be equal to the height of your columns (i.e. K=1), which is 12’ on typical floors. Lower floor column heights will be obvious when you are done with the design of your truss and will have to be rechecked at final stage.

3- Design your truss: determine loads being received by the truss and determine member sizes after assigning a depth to the truss. From there you will find the most heavily loaded member and assign a section using the concept of slenderness ratio (KL/r). Assume that no lateral force is being picked up by the truss and no horizontal reactions at supports. For allowable stress for tension members use 30 ksi.

4- After designing your truss, make sure to check the columns at ground floor to ensure they are within the “safe zone.”

Your report should arrange the following in a letter size format. Number of pages is up to you. At a minimum, your report should include the following.

- Title page with an image of your choice that is relevant to the project.
- Table of contents and intro explaining, in narrative form, what the purpose of the report is, what the major structural components are, how the structure is configured.
- Second floor framing plan: showing all beams, girders, columns as well as bracing locations. Specify a label to each specific type of beam and girder and list the size of the member as a W section directly on the drawing or as a chart next to it. Include a graphic scale.
- Elevation of the truss with loads applied at each joint and member forces. To resolve this you need to assign a height to the truss. This is an architectural decision, the deeper the truss, the higher the first floor will be, making your columns more slender and possibly creating an odd façade condition.

- Elevation of the truss with compression and tension members shown in different colors with member forces noted. You can follow this diagram with another elevation of the truss with thicker lines showing heavily loaded members etc. (see example from my truss lecture slides)

- Determine the compression and tension bars with the heaviest loading and assign these W-sections using KL/r ratio. Calculate the overall weight of the truss and find the efficiency ratio assuming all tension and compression members are the same size. (weight of truss/ supported weight)

- Bonus attempt: Try resizing each member to their lightest cross section possible and check the efficiency ratio again. How did it differ?

- Document all your work showing your trial and error process determining bar sizes. Properly formatted, readable, neat hand calculations are OK.

- Front and side elevations with well placed wind bracing. Explain why this configuration makes sense structurally and architecturally. In elevations show structural members per their actual sizes as opposed to single lines.

- One page minimum per each student on how you would work on this project if this was your own office. How would you change the structure? Would you try to convince Owner to go about getting a column free space some other way? What other alternatives in steel could you propose including general framing, wind bracing, façade expressions or other detailing ideas in order to give the building a more tectonic expression? Please include at least one sketch or a drawing to express your idea(s). You may refer to your previous assignment or other books as a reference for ideas. You are also welcome to discuss your “take away” from this class and the three projects in general in terms of the relationship between structure and architectural space expression.

Format
A single 8.5x11 PDF document submitted electronically in a proper sequence. It is your responsibility to ensure your file is small enough to e-mail, ideally no more than 8MB. If your file is too big to e-mail, please send it via a free large format delivery service such as yousendit.com for me to download. I will print a copy of your documents on a black and white printer for grading etc. I may also show some of your work in the class.

Grading Criteria
Your project will be graded using a 100 point base grade. All team members will receive the same 80% of the group base grade barring unusual circumstances. The last 20% will be based on your individual page and participation.

- Timeliness: Submission past 5:00 pm will reduce your base grade to 90; a November 21st submission will reduce your base grade to 80 and further 10 point reduction for each day late following thereafter.

- Format: Professionalism, neatness, graphics, clarity as always…

- Content: The idea is for you to familiarize yourselves with typical office practices where architects are quite dependent on a fruitful collaboration with engineers to bring structural design issues to a closure. This project presents a culmination to your three project long adventure into structures that focused respectively on identifying, analyzing and designing specific structural members and combined configurations. My hope is that your intuitive eye and intuitive hand have improved and you will reap the benefits of design and building technology classes through your school years and once you are in practice.
1- Connection detail for a suspension structure shown. All rods are on the same plane. If Rod C is supporting a load of 1200 lb, determine the loads on Rod A and Rod B. You may use graphic or numerical method. (35 points)

2- Three concurrent forces at point O shown. If $T_1 = 3000$ lb, determine $T_2$ and $T_3$ to ensure resultant force developed is 7500 lb vertical along the axis of the pole. (45 points)

3- Concrete column-footing combination shown. Given the force $F$ applied on the structure, determine ground reaction $R_{soil}$ and the forces developed in the mid section of the column. Column: $1\times1\times10'$
Footing: $5'\times5'\times1'$
Concrete: 150 pounds per cubic feet (lb/cf)
(20 points)
1- An eye screw attached to a ceiling with A, B and C forces applied as shown. No bending is desired in the eyescrew (i.e. no horizontal resultant component in the resultant force).
   a- Determine force C graphically.
   b- Determine resultant pull force applied on the eye screw graphically.
   c- Determine L, if the eye screw is capable of carrying a vertical pulling force of 150#/in of penetration.
   d- Determine stress developed in section S if the screw has a diameter of \( \frac{3}{4} \)".
   Graphic scale: 5mm = 25# (20-20-12-12 points)

\[ A = 130# \]
\[ B = 165# \]

2- 500 N force applied on point D of a bent steel plate as shown. Compute:
   a- Moment about A
   b- Moment about B
   c- Moment about C. (12 points each)
1- For the beam system shown.
   a- Draw free body diagrams. (12 points)
   b- Determine reactions at A, C and D. (36 points)
   c- Determine forces transmitted at B. (12 points)

2- Determine the support reactions for the truss at supports A and B. (40 Points)
1- Determine the support reactions for the truss at supports A and D. (40 Points)
2- Determine forces at AB, BC, CD, DA and DB. (40 Points)
3- Draw FBD of whole structure indicating whether each member is in tension or compression. (20 points)

HINT:
- You may use: \( \sin 36.86^\circ = 0.6 \) \( \cos 36.86^\circ = 0.8 \)
- Suggested order of analysis: Joint A, Joint B, Joint D
1- A roof truss with unevenly distributed snow load shown. What is the axial force developed in the diagonal web member that is cut by section x-x? Select one. (all loads are in kips)

a - 0.7 compression  
b - 0.7 tension  
c - 1.0 compression  
d - 1.0 tension  
e - 1.4 compression  
f - 1.4 tension

2- Assume all pin joints for the truss shown. Determine 0-force members. Type member names in boxes below.

3- During the design phase of a multistory building, it is found out that overall height has to be reduced. Engineer informs the architect that the depth of the floor trusses can be reduced but the members will have to be resized. Ignoring the weight of the truss, what assumptions can be made by the architect? Select True or False for each statement.

T F Members IF and OB are in compression.  
T F Upper chord of the truss is in tension.  
T F Following design revision, axial loading on each of the vertical members will increase.  
T F Following design revision, axial loading on each of the diagonal members will increase.

4- For the three-hinged arch structure shown, what are the vertical components of the reactions developed at A and B?

\[ A_y = \quad \quad \quad B_y = \quad \quad \quad \]

5- For the arch shown above draw the free body diagrams of both segments of the arch in the space provided on left. Also select True or False for each statement.

T F \( A_x \) is greater than \( B_x \).  
T F If the height of the arch is increased, reactions at A and B will be decreased.

Bonus - 10 points: Calculate \( A_x = \) \quad and \( B_x = \) \quad
1- The shearwall shown receives 64K of dead load from the floors it supports right at its center axis. What is the factor of safety against overturning if resisted only by gravity forces? Ignore the weight of soil over footing. Density of concrete: 150 pcf (20 points)

a- 1.5  
b- 2.5  
c- 3.75  
d- 5.75  
e- 6

2- Single family house section shown.  
   Roof loads: LL: 15 psf (snow, horizontally projected)  
   DL: 12 psf  
   What is the total equivalent (horizontally projected) load per linear foot applied on the rafters spaced at 24” on centers? (20 points)

a- 13.5 plf  
b- 27 plf  
c- 41.8 plf  
d- 56.8 plf  
e- 60.3 plf

Following preliminary design, it is decided that the roof pitch is increased to 9:12 from 6:12. Select true or false. (12 points ea.)

T  F  Total load transferred to bearing walls will increase.  
T  F  Horizontal thrust transferred to bearing walls will increase.

3- For the framing plan shown where DL+LL= 60 psf, determine the following: (ignore weight of beams) Suggestion: sketch individual FBD's of relevant beams. (12 points ea.)

Column load @ F2=  
Column load @ E1=  
Column load @ E3=  
1- Explain in one sentence, what is wrong with this building in terms of lateral load resistance? Sketch a solution right on the drawing. (25 points)

2- Explain in one sentence, what is wrong with this multistory building plan in terms of lateral load resistance? Propose and sketch a solution right on the drawing. (25 points)

3- What is the lateral load resisting system of this building? Sketch a basic detail of column+beam connection. (25 points)

4- A new canopy will be added in front of an existing building. Assume composite decking is 25 psf. What are the reactions at point A and B. Ignore weight of beam and columns. (25 points)
For the overhanging beam shown:

1- Calculate reactions. (20 points)
2- Draw shear diagram. (20 points)
3- Draw moment diagram. (20 points)
4- Calculate max moment. (20 points)
5- Determine the point where moment is 0. (inflection point) (20 points)

REATIONS: 
@B:
@C:

SHEAR DIAGRAM

MOMENT DIAGRAM

MAX MOMENT:

INFLECTION POINT: (distance from A or B)