

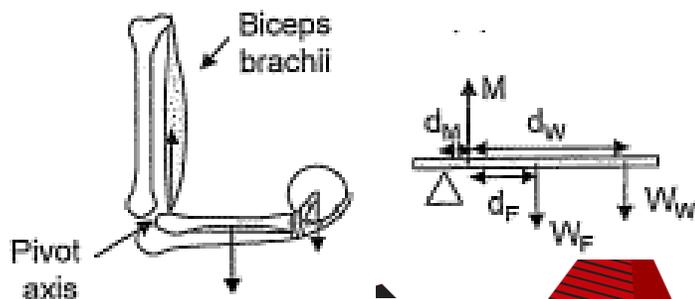


Using MATLAB in a Flipped Undergrad Biomechanics Class

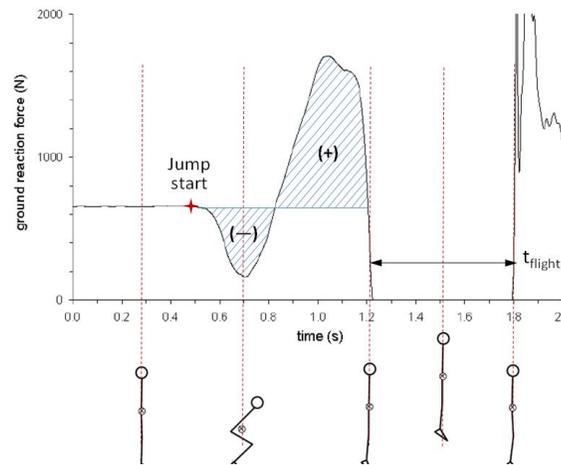
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Our Class: Biomechanics

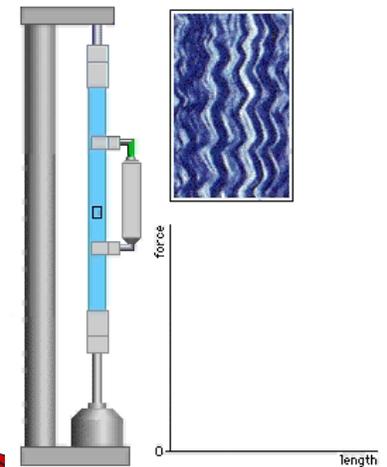
- Core departmental course
- 80-100 Undergraduates
- Varying degree of MATLAB experience
- Analyze human movement using basic principles of engineering mechanics as tools for discovery and understanding



Biostatics



Biodynamics



Tissue Biomechanics

Flipped Classroom

- Pedagogical model with traditional lecture and practice components reversed
- Face-to-face classroom time utilized for interactive group problems solving and discussion of difficult concepts
- Need for engineering graduates to be able to solve real-world problems and work in teams



Walvoord et al. (1998) *SF: Jossey-Bass*
Lage et al. (2000) *J Econ Educ*

Course Structure

- Online lectures
 - 10-15 min content based lectures

Question 2

1 pts

Use the dropdown menus to indicate which of the following statements apply to trusses, and which of the following statements apply to frames.

1. These systems can be analyzed using the following methods: whole structure, method of joints, method of sections.

✓ [Select]

frames

trusses

[Select]

2. These systems have a member subjected to 3 or more forces at various points.

3. These systems are often used to represent bony anatomy.

[Select]

4. These systems represent all members as two force members, where equal and opposite forces act along the axis of each member, creating either tension or compression.

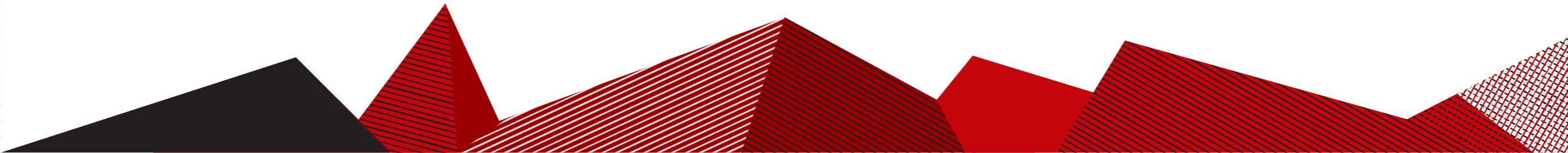
[Select]

5. These systems have straight members with negligible weights that are only connected at their ends via pin joints.

[Select]

Course Structure

- Online lectures
 - 10-15 min content based lectures
- In-Class Time
 - Active learning



In-Class Time: ACL Example

- You are testing ACL reconstructions with an orthopedic surgeon. You record the following load-deformation data for an experimental ACL reconstruction in an animal model. The harvested reconstructions were tested in tension until the ligament reached failure. The ACL cross-sectional area was 126 mm^2 and the bone-to-bone resting length of the ligament was 29.5 mm . Plot the stress strain curve and determine the mechanical properties listed below.

- Young's Modulus
- Yield Strength
- Ultimate Strength
- Rupture Strength

Displacement (mm)	Load (N)
0.00	0
0.01	0
0.02	10
0.03	37
0.04	96
⋮	⋮

Course Structure

- Online lectures
 - 10-15 min content based lectures
- In-Class Time
 - Active learning
- Homework

Question 4

5 pts

Determine the area of the force plate if it is known that at an instant in time a subject steps on the plate at location $(-1.13 \text{ m}, -0.77 \text{ m})$, and the readings of the 4 load cells are such that their x and y components are zero and their z components are as follows: $F_{1z} = 245 \text{ N}$, $F_{2z} = 143 \text{ N}$, $F_{3z} = 299 \text{ N}$, $F_{4z} = 204 \text{ N}$. Assume that the load cells are located at the corners of the force plate. You cannot assume that the force plate is square. Enter your answer in units of square meters.

Note: Do not be alarmed if you get large area values!

Question 10

0 pts

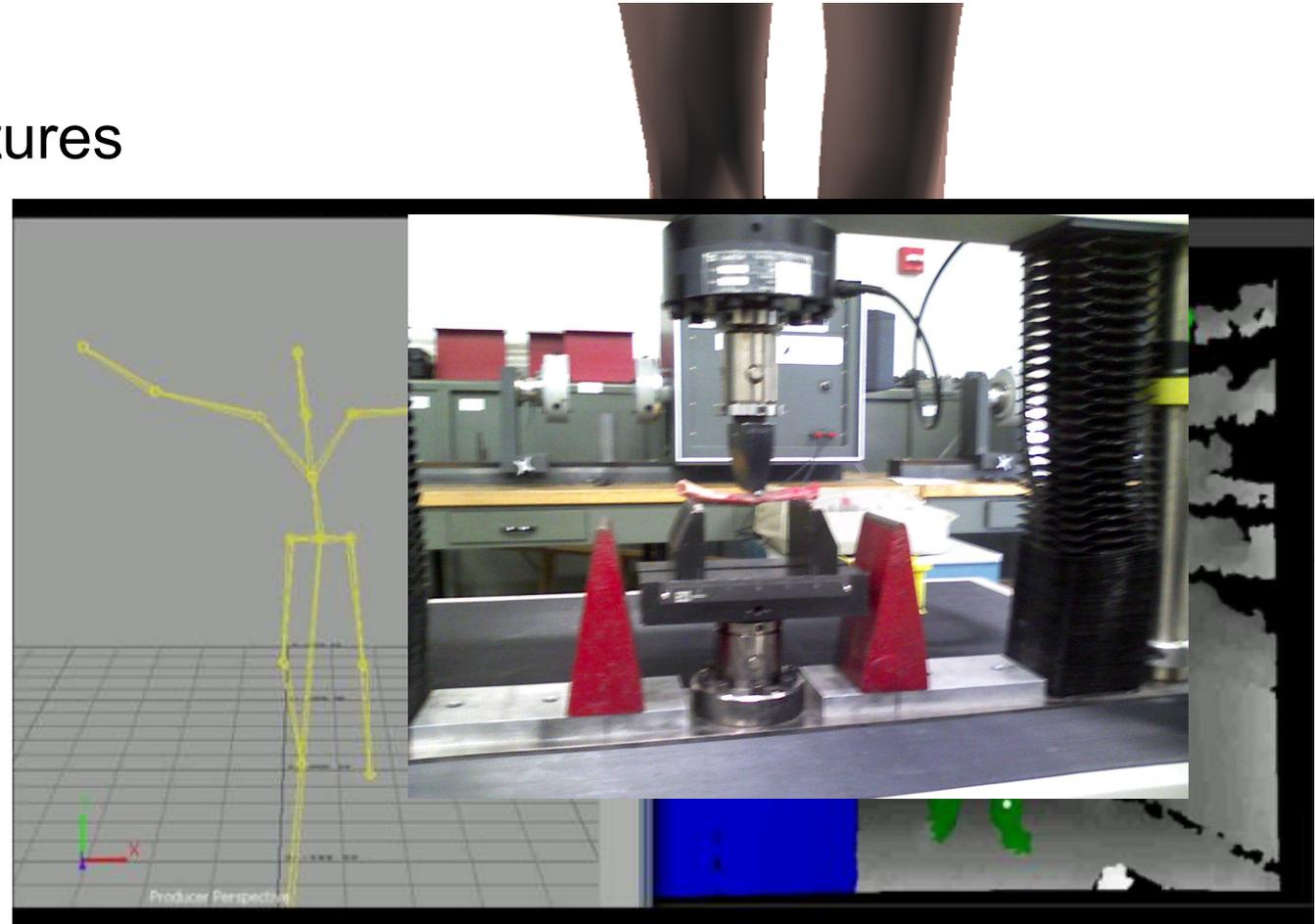
Please attach scanned documentation of your work.

Upload

Choose a File

Course Structure

- Online lectures
 - 10-15 min content based lectures
- In-Class Time
 - Active learning
- Homework
- Laboratory sessions
- Exams



Teaching MATLAB

- MATLAB Onramp
- MATLAB Grader for introduction
- Homework assignment completed on LMS
 - Analysis in MATLAB and answers in LMS
 - Upload



A is a 3x4 matrix.

```
      2 7 9 7
Let A = 3 1 5 6
      8 1 2 5
```

The screenshot shows the MATLAB Grader interface. The top navigation bar includes 'Courses & Content', 'LMS Integration', and 'Documentation & Support'. The main content area displays the course title 'Biomechanics- BME 315' and the current page 'Getting Started with Matlab'. The title of the current problem is 'Race Times (file input, calculation, datatypes, structure array)'. Below the title is a progress bar with a green segment and a red segment. The 'Problem Summary' section describes the task: 'The file **RaceResults.dat** is already saved in the same folder as your script and contains five columns of single precision data. The first column represents bib numbers for the racers. The second through fifth columns are the racers' times (in hours) for each of the four races. Do the following:'. A list of tasks follows: 'Compute the mean race time (over the four races) for each racer.', 'Sort the data according to the mean race time, with the fastest (lowest) time first.', 'Compute the average mile pace in minutes/mile for each runner by dividing their mean race time in minutes by the mile distance (0.310686 miles).', and 'Convert the Bib Number data from the input file to unsigned 8-bit integer datatype.'. Below the tasks, it says 'Assign the results to a structure array named **processedRaceResults** with three fields as follows:'. A final list of fields: 'The **BibNumber** field should contain the integer bib numbers corresponding to the sorted data.', 'The **MeanTime** field should contain the corresponding mean race times.', and 'The **MilePace** field should contain the mile pace corresponding to each bib number.'

MATLAB Grader

CONTENTS Close

Biomechanics- BME 315

Reorder Content

Getting Started with Matlab

My first SCRIPT problem

Grade Roster Sort (file I/O)

Race Times (file input, calculation, datatypes, structure array)

Projectile trajectory (plot of multiple data series)

ADD PROBLEM

ADD ASSIGNMENT

Manage People

Courses & Content | LMS Integration | Documentation & Support

Biomechanics- BME 315 > Getting Started with Matlab >

Race Times (file input, calculation, datatypes, structure array)

Problem Summary

The file **RaceResults.dat** is already saved in the same folder as your script and contains five columns of single precision data. The first column represents bib numbers for the racers. The second through fifth columns are the racers' times (in hours) for each of the four races. Do the following:

- Compute the mean race time (over the four races) for each racer.
- Sort the data according to the mean race time, with the fastest (lowest) time first.
- Compute the average mile pace in minutes/mile for each runner by dividing their mean race time in minutes by the mile distance (0.310686 miles).
- Convert the Bib Number data from the input file to unsigned 8-bit integer datatype.

Assign the results to a structure array named **processedRaceResults** with three fields as follows:

- The **BibNumber** field should contain the integer bib numbers corresponding to the sorted data.
- The **MeanTime** field should contain the corresponding mean race times.
- The **MilePace** field should contain the mile pace corresponding to each bib number.

Teaching MATLAB

- Data analysis in lab setting

```
% Plot your raw data and inspect it to make sure it looks as you expect
figure;
plot(force);

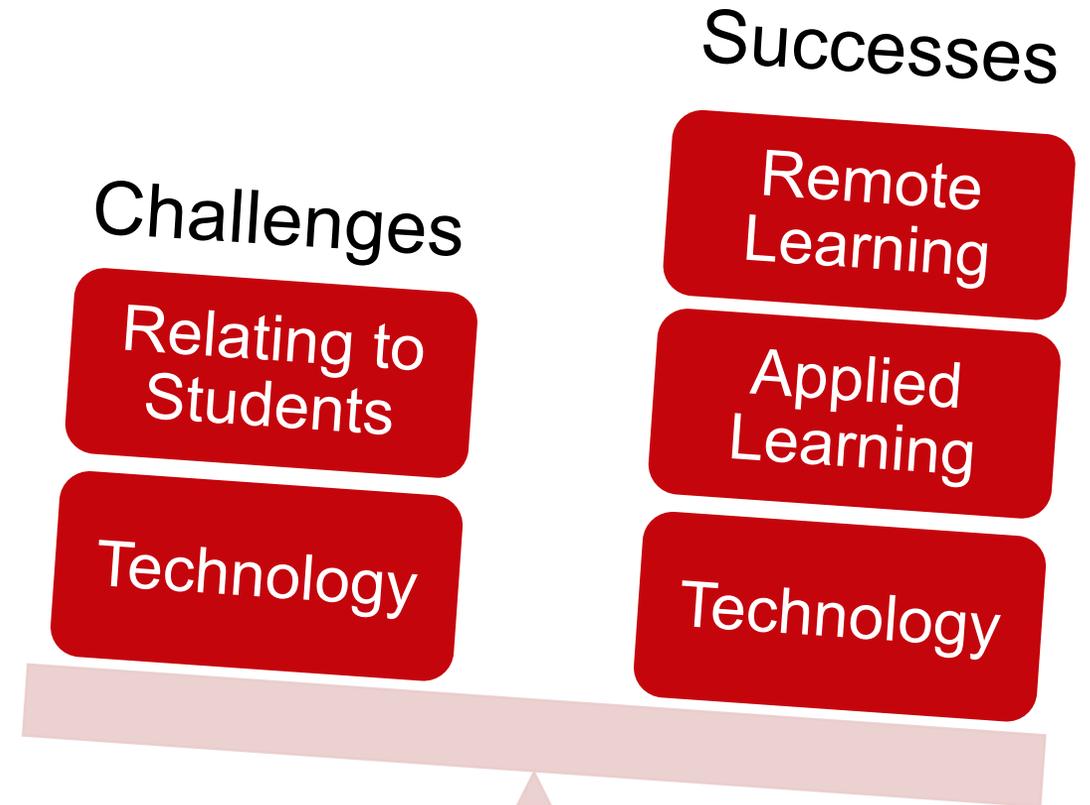
% Record the first and last frame of the linear region of the loading
curve
% Enter the gauge length and cross-sectional area for the specimen
j1=input('Enter first frame of the linear region of loading curve');
j2=input('Enter last frame of the linear region of the loading curve');
Lo=input('Enter the gauge length');
A=input('Enter the cross-sectional area of your specimen');

% Calculate tendon stress and strain, being careful to use consistent
units.
stress=...
strain=...

% Plot tendon stress and strain, being careful to use consistent units
```

Conclusion

- Success of course model
 - Remote learning
 - Applied examples
 - Self paced learning
 - Professional development
- Future Work
 - MATLAB problems in an exam
 - Continue to build MATLAB grader questions



Thank You!



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