Tutorials 1 & 2

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Fall 2022

Land Acknowledgment

I wish to acknoledge this land on which the University of Toronto operates. For thousands of years it has been the traditional land of the Huron-Wendat, the Seneca, and most recently the Mississaugas of the Credit River. Today, this meeting place is still the home of many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.

Course Contacts

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- Teaching Assistants (TAs)
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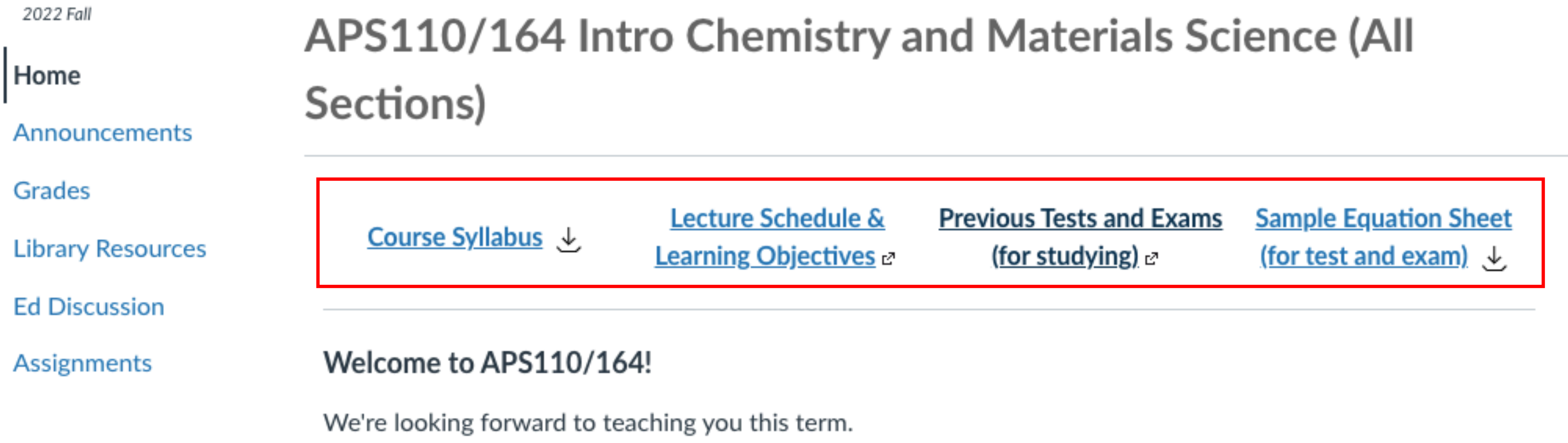
    - For grade disputes

Health Resources

- UofT Mental Health Resources
  - mentalhealth.utoronto.ca
- FASE Mental Health and Wellness
  - www.engineering.utoronto.ca/mental-health-wellness
- Time Management
  - Academic Success
    studentlife.utoronto.ca/department/academic-success
  - First Year Advisor
    undergrad.engineering.utoronto.ca/first-year-office-2/first-year-office-team

Course Resources

- Quercus:



- Top Hat Textbook
- Ed Discussion Forum

Mark Breakdown

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- Problem Sets
  - 3 in total
  - Submitted on Quercus
- Quizzes
  - 3 in total
  - Available for 24h
  - Must be finished in 30min
  - Only 1 attempt
- Exams
  - Midterm + Final
  - Equation Sheet

- Top Hat Questions
  - 2 attempts for full mark
  - Half a mark for trying ☺
- Dates on Quercus (*Assignments*)
- Topics in *Lecture Schedule & Learning Objectives*
- Weights:

Term Test	30 %
Online Top Hat Textbook Questions	5 %
Problem Sets	10 %
Quizzes	10 %
Final Assessment	45 %
TOTAL	100 %

Types of Materials

- **Metals**
- **Polymers**
  - Large molecules with repeating unit
- **Ceramics**
- What is left out? Semiconductors, Nanomaterials, Biomaterials, Composites

Anouncements

- First problem set due on October 7th will be posted late this week or early next week.
- Quizzes in tutorials are not for credit. Only the quizzes on Quercus will be graded for credit.
- TopHat problems – If you answer correctly on the first or second attempt, you will get a full mark. If you attempt it twice but get it wrong both times, you will get half a point.

Theory Review

Greek Letters

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Α α alpha
Β β beta
Γ γ gamma
Δ δ delta
Ε ε epsilon

Ζ ζ zeta
Η η eta
Θ θ theta
Ι ι lota
Κ κ kappa

Λ λ lambda
Μ μ mu
Ν ν nu
Ξ ξ xl
Ο ο omikron

Π π pi
Ρ ρ rho
Σ σ/ς sigma
Τ τ tau
Υ υ upsilon

Φ φ phi
Χ χ hi
Ψ ψ psi
Ω ω omega

Sample Problems

1. A cylindrical rod with a diameter of 12.5 mm and a length of 600 mm is loaded in tension. If the rod is expected to not plastically deform or elongate more than 1.4mm under an applied load of 29 kN, which of the four metals can be used for this application? A list of materials can be found below -

Material	Young's Modulus (GPa)	Yield Strength (MPa)	Tensile Strength (MPa)
Aluminum	70	255	420
Brass	100	345	420
Copper	110	210	275
Steel	207	450	550

Sample Problems

2. Sketch a figure for the net interatomic forces versus interatomic spacing between two atoms. Clearly label the axes and indicate the shape of the curve for the attractive forces, repulsive forces, and net force.
    a. Indicate the source of each of these forces and discuss the significance of the point where the net force curve intersects the horizontal axis
    b. Explain the relationship of Young's Modulus to this curve and why it is a structure-independent property

Quizz (not graded)

1. During a tensile test of a given material, Young's modulus depends on:
   a. The length of the sample
   b. The diameter of the gauge region
   c. The angle of the sample's shoulders
   d. None of the above

2. Two ropes are cut, the first to 1m in length and the second to 3m in length. Both pieces of rope are stretched by 2cm. What will the ratio of the strain in the first to the strain in the second?
   a. 3
   b. Equal to one another because strain is sample size independent
   c. 0.33
   d. 2

3. A component you are designing must withstand an applied stress of 900 MPa. The dimensions of the component are: 12 mm wide, 35 mm height, and 67 cm long. Assuming you apply the load along the long axis, what is the maximum load associated with this applied stress?

Quizz (not graded)

4. A tensile stress is to be applied along the long axis of brass tensile specimen that has an initial gauge length l_0 = 30 mm. The whole tensile specimen is 2.0mm thick, with the grip region being 1.2cm wide and the reduced section half that width. Determine the magnitude of the load required to produce a 0.15 mm change in the gauge length if the deformation is entirely elastic. (brass modulus E = 97 GPa)

5. Consider a person attempting to pop a balloon with a series of nails, assuming they are only able to apply a maximum force of 100N with their arms. A balloon typically bursts when a pressure of 110kPa is applied to its surface. Considering that they could effortlessly pop the balloon with a single nail when applying 5.5N, what is the minimum number of nails on the wooden board for this experimenter to be completely incapable of bursting this balloon? (Consider that the pressure is distributed equally among the nails)

6. A hypothetical metal has a Young's modulus of 200 GPa and a yield strength of 600 MPa. This cylindrical sample with a diameter of 10mm and a length of 500mm has elongated to a final length of 506 mm. Is this bar undergoing elastic or plastic deformation? If this were purely elastic deformation, what is the maximum length that the sample could elongate to?

Quizz (not graded)

Answers:

1) D
2) A
3) 378 kN
4) 5.82 kN
5) 19
6) Plastic Deformation, 501.5mm

Quizz (not graded)

Solution for Question 6

- By stretching the sample from L_0=500mm to 506 mm, we're producing an elongation ΔL of 6mm, which represents a strain of $\epsilon=\Delta L/L_0=0.012=1.2\%$
- Is this strain enough to deform the material plastically? We know that its Yield Strenght is $\boldsymbol{\sigma}_Y$=600MPa (a value of stress). That's where plastic deformation begins. The "yield point" in the stress-strain curve is part of the linear (elastic) region, which means it obeys Hooke's Law. Therefore we can use Young's Modulus (given as E=200GPa) to relate stress to strain. Doing so gives us $\epsilon_Y=\boldsymbol{\sigma}_Y/E=0.003=0.3\%$. This is the strain where plastic deformation begins
- The applied strain $\epsilon=1.2\%$ is higher than the strain where plastic deformation begins ($\epsilon_Y=0.3\%$), therefore **we are indeed deforming the material plastically**
- The maximum strain we can have in this material without deforming it plastically is $\epsilon_Y=0.3\%$. For this sample with an initial length of L_0=500mm, this strain means an elongation of $\Delta L=L_0*\epsilon_Y=1.5$mm which gives us a final length of 500mm+1.5mm=**501.5mm**