# Welcome PHYS 170 students!

# Please pick up a handout from the front of the lecture theatre

# PHYS 170
# Lecture 1
# September 5, 2018

# Course Overview

- **Instructor:** Dr. Matthew (Matt) Choptuik
  Prof. of Physics and Astronomy
  **Office:** Hennings 403
  **Phone:** (604) 822-2412
  **Email:** choptuik@physics.ubc.ca
  **Office hrs:** Tuesday, 11 AM-12 noon, or by appt. via email

- **Text:** R.C. Hibbeler, *Engineering Mechanics: Statics and Dynamics,* (3rd Custom Ed. of the 14th Ed.)

- **Schedule:** See handout for detailed lecture schedule.  We will cover most of chapters 1, 2, 3, 4, 5, 8, 12, 13, 14 and 15

- **Canvas:** Detailed information concerning the course, including copies of lecture slides, are available on the course Canvas site

# Course Overview

**MARKS**

| | |
|---|---|
| Final Exam (covers all course material) | 50 |
| October Exam | 20 |
| November Exam | 20 |
| Mastering Engineering Assignments | 5 |
| Tutorial Assignments | 5 |
| **Total** | **100** |

Grading policy (Important!): You must obtain a total of at least 45 marks out of 90 on the three exams (Final Exam, October Exam, November Exam) for your marks from Mastering Engineering Assignments and Tutorial Assignments to count towards your Final Grade.  In other words, you cannot pass the course as a whole without passing the exam component of the course.

# Course Overview

- Chap. 1: General Principles
- Chap. 2: Force Vectors
- Chap. 3: Equilibrium of a Particle
- Chap. 4: Force System Resultants
- Chap. 5: Equilibrium of a Rigid Body
- Chap. 8: Friction
- Chap. 12: Kinematics of a Particle
- Chap. 13: Kinetics of a Particle: Force and Acceleration
- Chap. 14: Kinetics of a Particle: Work and Energy
- Chap. 15: Kinetics of a Particle: Impulse and Momentum

# Course Overview
## Homework—Mastering Engineering

- You will be completing your homework using an online system called Mastering Engineering (ME)

- The homework problems are taken from the text, but the data (numeric values for quantities) are randomized so that each student has a distinct set of correct answers

- You need an access code for ME which you can obtain from the bookstore either bundled with the textbook, or in standalone form

- You must first register for the course, using the access code: see instructions in "Getting Started with Mastering Engineering" on Canvas, also included in handout package

- Purchasing access to ME highly recommended (though not compulsory)—the more problems you work in this course, the better your understanding and exam performance is likely to be

# Course Overview
## Tutorials

- Tutorials start next week (week of Sept 10)

- In each tutorial you will work in a small group—3 or 4 students—to solve and write up a single problem from the text—groups will be constituted in the first tutorial

- Instructions describing how problems are to be completed and written up are available on Canvas in the document "Information About Tutorial Assignments", also included in the handout

- TAs will be leading the tutorial sections and will go over the instructions with you when you first meet—the TAs for the various sections, and their e-mails, are given in the handout

# Course Overview
## Piazza

- Will be using a Piazza forum as the chief mechanism for posing and answering questions concerning the course

- In particular, rather than e-mailing me with a question, you should create a post in the Piazza forum, which will then, with luck, be answered by me, or by one or more of your fellow students, or by one of the TAs.

- Further information about this forum is available in the handout ("General Information" document on Canvas)

# Calculators

- Recommended calculator for course: TI 84+ (or TI 83, or other comparable TI graphing calculator).  Staples' cost $135
    - Key capabilities:
        - Solve systems of linear equations in several variables
        - Solve nonlinear equation in a single variable
    - Has memory structure that we will use to advantage in many problems


- Use of TI graphing calculator is not mandatory.  There are less expensive options that will suffice, but you should ensure that whichever calculator you buy/own is capable of solving at least 3 linear equations in 3 unknowns


- Examples
    - Sharp EL-W516X (About $46 at Staples)
    - Casio fx-9991MS (About $20 at Staples)

# Web Based Calculation

- In addition to calculators you can also use web resources to help you with calculations you need to do for homework assignments and self-study (but *not* for tutorials or exams)

- One of the most powerful such resources—yet one that is easy to use for tasks such as solving linear equations is WolframAlpha, available at https://www.wolframalpha.com
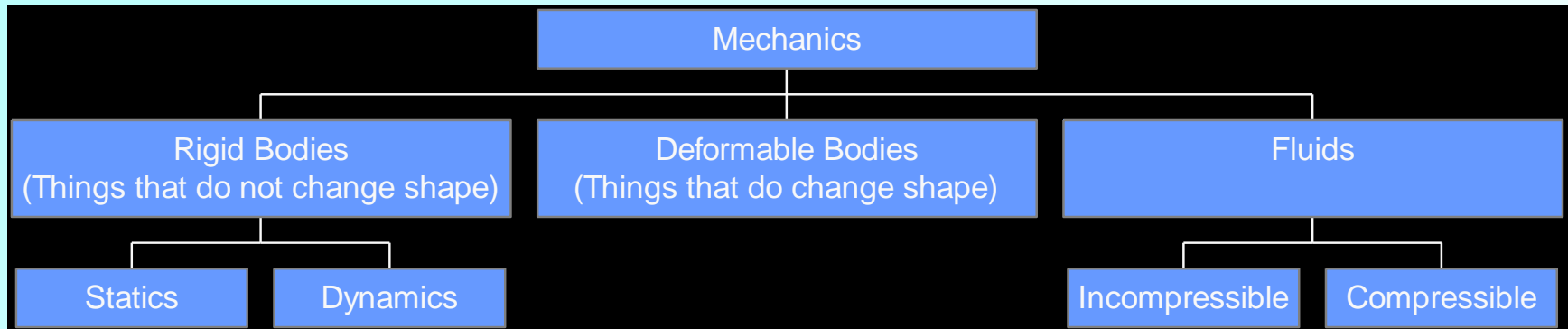
# LECTURE OVERVIEW

- Very quick overview of Ch. 1 (refer to text for more information, contact me [Piazza, office hours] if you have any questions)

- Present here only as summary of what you should know

# CHAPTER 1:  GENERAL PRINCIPLES

1.  Mechanics
2.  Fundamental Concepts
3.  Units of Measurement (SI, FPS)
4.  The International System of Units
    - Rules for use, including prefixes
5.  Numerical Calculations
    - Dimensional homogeneity, sig. figs., rounding, sig. fig. convention
6.  General Procedure for Analysis

# BRANCHES of MECHANICS

```
                          ┌─────────────────┐
                          │    Mechanics    │
                          └─────────────────┘
          ┌───────────────────────┼───────────────────────┐
┌───────────────────┐   ┌───────────────────┐   ┌───────────────────┐
│   Rigid Bodies    │   │ Deformable Bodies │   │      Fluids       │
│(Things that do not│   │(Things that do    │   │                   │
│   change shape)   │   │   change shape)   │   │                   │
└───────────────────┘   └───────────────────┘   └───────────────────┘
     ┌─────┴─────┐                                   ┌─────┴─────┐
┌─────────┐ ┌─────────┐                     ┌──────────────┐ ┌────────────┐
│ Statics │ │Dynamics │                     │Incompressible│ │Compressible│
└─────────┘ └─────────┘                     └──────────────┘ └────────────┘
```

- NOTE: Point particles are further specialization of rigid bodies

# Unwanted Dynamics
## (Tacoma Narrows Bridge, November 1940)
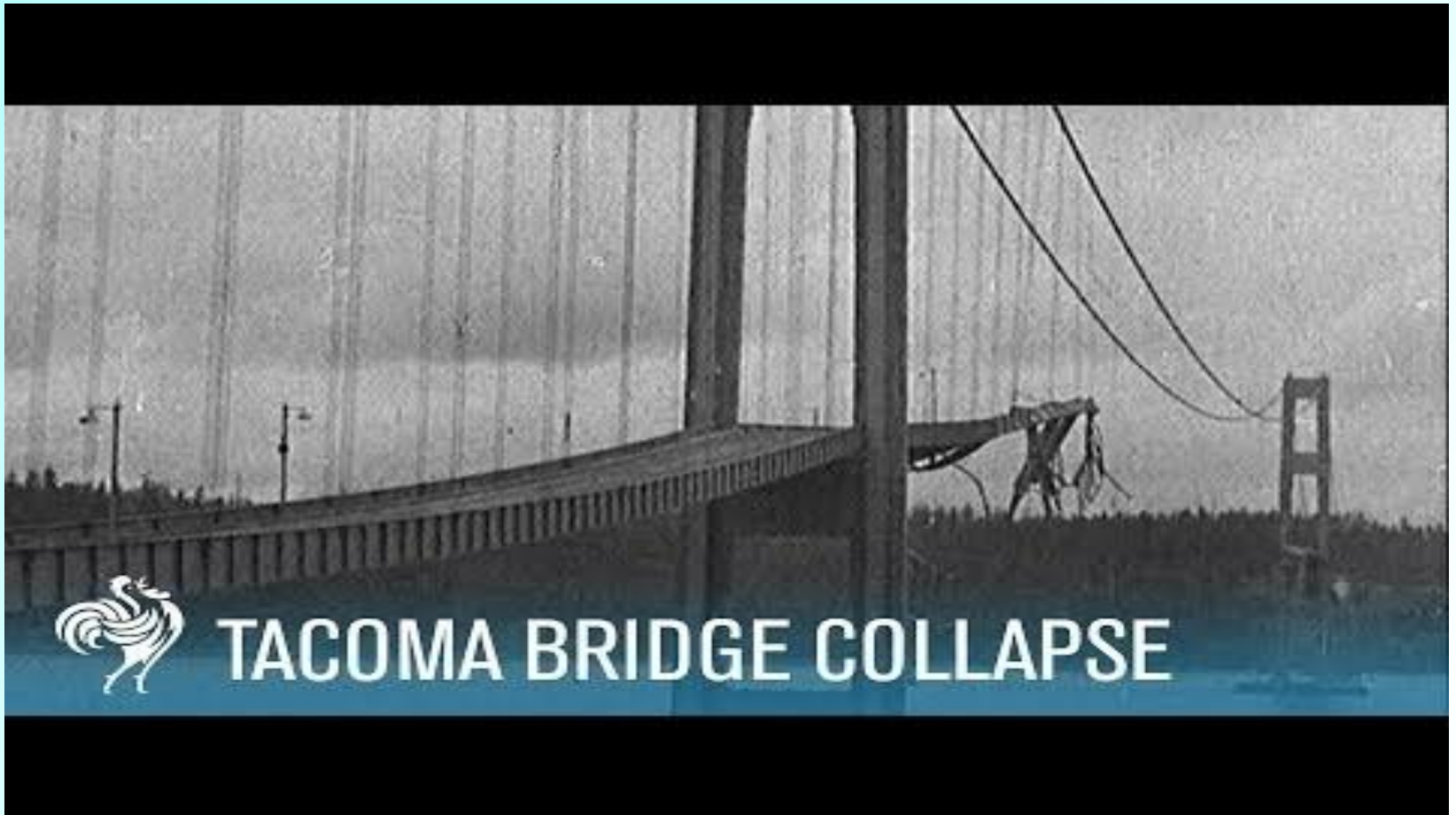
# FUNDAMENTAL CONCEPTS

- Basic quantities: length, time, mass, force
  - Only three of four are independent, take length, time, mass to be fundamental

- Idealizations: particle (mass, negligible size), rigid body (mass, finite size, but does not deform under load), concentrated force

- Newton's three laws of motion, including 2$^{nd}$ law

$$\mathbf{F} = m\mathbf{a}$$

# LAW OF GRAVITATION

FIRST PHYSICS LAW OF CARTOONS

GRAVITY WILL NOT WORK 'TILL YOU LOOK DOWN...

TURN THE GRAVITY BACK ON!

QUCK!!!

Funny Pictures on www.LeFunny.net

# LAW OF GRAVITATION

- Newton's universal law of Gravitation

$$F = G\frac{m_1 m_2}{r^2}$$

- Weight on surface of Earth

$$W = mg$$

NOTE: g varies from place to place on Earth. In calculations, use value corresponding to "standard location", g = 9.81 m/s$^2$, turns out to be the correct value for Vancouver

# UNITS OF MEASUREMENT

| Name | Length | Time | Mass | Force |
|------|--------|------|------|-------|
| International System of Units (SI) | meter (m) | second (s) | kilogram (kg) | newton* (N) $\left(\dfrac{kg \cdot m}{s^2}\right)$ |
| U.S. Customary (FPS) | foot (ft) | second (s) | slug* $\left(\dfrac{lb \cdot s^2}{ft}\right)$ | pound (lb) |

*Derived unit.

- NOTE:  kg is a unit of mass, while lb is a unit of force; mass in slugs = weight in lbs / 32.2

# SI PREFIXES

| Exponential Form | Prefix | SI Symbol |
|---|---|---|
| $10^9$ | giga | G |
| $10^6$ | mega | M |
| $10^3$ | kilo | k |
| $10^{-3}$ | milli | m |
| $10^{-6}$ | micro | μ |
| $10^{-9}$ | nano | n |

# NUMERICAL CALCULATIONS

- Dimensional homogeneity
  - All terms in equation must have same physical dimension (same units), useful for checking calculations!

- Rounding numbers
  - When rounding a number that ends in 5:

    "Round to even digit rule": 2.345 -> 2.34 (round down), but 2.355 -> 2.36 (round up)

- Significant figures (sig. figs.)
  - Accuracy of number specified by number of significant figures it contains
  - Default for final answers: **3 sig. figs.** (generally carry 4 [or more] for intermediate values)

# DIMENSIONAL HOMOGENEITY EXAMPLE

Consider the dimensional homogeneity of

$$F = G \frac{m_1 m_2}{r^2}$$

Let $[Q]$ denote the SI unit of quantity $Q$, as expressed using m, s and kg.   Then

$$[F] \ ? = [G] \frac{[m_1][m_2]}{[r^2]}$$

$$\mathrm{kg} \cdot \mathrm{m} \cdot \mathrm{s}^{-2} \ ? = (\mathrm{m}^3 \cdot \mathrm{kg}^{-1} \cdot \ \mathrm{s}^{-2})(\mathrm{kg}^2)(\mathrm{m}^{-2})$$

$$\textcolor{red}{\mathrm{kg} \cdot \mathrm{m} \cdot \mathrm{s}^{-2} = \mathrm{kg} \cdot \mathrm{m} \cdot \mathrm{s}^{-2}}$$

and we have established that the equation is dimensionally homogeneous

# GENERAL PROCEDURE FOR ANALYSIS

- Quoting Hibbeler: "The most effective way of learning the principles of engineering mechanics is *to solve problems*"

- Read the problem carefully and try to correlate the actual physical situation with the theory studied

- Tabulate the problem data and *draw to a large scale* any necessary diagrams

- Apply the relevant principles, generally in mathematical form. When writing any equations, be sure they are dimensionally homogeneous.

- Solve the necessary equations and report the answer with no more than three significant figures

- Study the answer with technical judgment and common sense and determine whether or not it seems reasonable.