

# Implementing the WeBWork open online homework system in second-year courses across a faculty of engineering

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## WHAT HOMEWORK SYSTEMS HAVE YOU PREVIOUSLY USED?

Respond at **[www.slido.com](http://www.slido.com)**

with this code: **#B198**

List a homework system you have used previously if it is not there, or upvote one listed already if you have used it.



**PICK A HOMEWORK SYSTEM YOU ARE MOST FAMILIAR WITH, WHAT ARE SOME STRENGTHS/WEAKNESSES OF THIS HOMEWORK SYSTEM?**

Respond at **[www.slido.com](http://www.slido.com)**

with this code: **#B198**

List a strength (+) or weakness (-) if it is not there, or upvote one listed already if it applies to the system you are thinking of.



## WHAT IS WEBWORK?

- Online homework system primarily used for **math**; increasingly used in **engineering**, but also **physics, chemistry, statistics, economics, geography...**
- Uses a programming language to specify exercises allowing instructors flexibility in problem presentation
- Provides unique question values to each student, instant feedback on answers (chance to correct errors), auto-grading of homework, shareable content via open-source problem bank
- Originally developed at the University of Rochester; now supported by the National Science Foundation and the Mathematical Association of America (MAA)
- Maintained by many contributors at a number of colleges and universities

## WHY WEBWORK?

- Open-source and free
- Highly customizable
- Familiarity for our students through 1<sup>st</sup> year Math at UBC
- Independent of LMS
- Support through universities and the community
- Homework systems becoming a regular part of textbooks



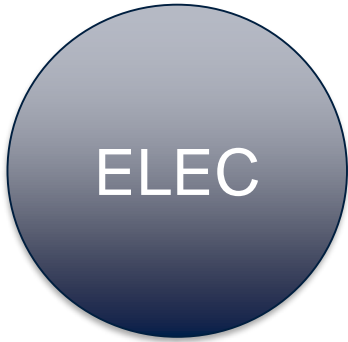


# USE OF WEBWORK IN UBC ENGINEERING BEFORE THIS PROJECT

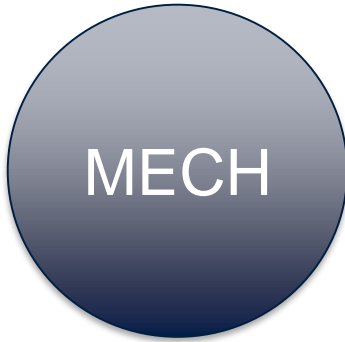
Departments working in isolation.

No (or very few) questions available openly.

No sharing of questions in courses that may have content overlap.



Electrical and Computer  
Engineering (ELEC)



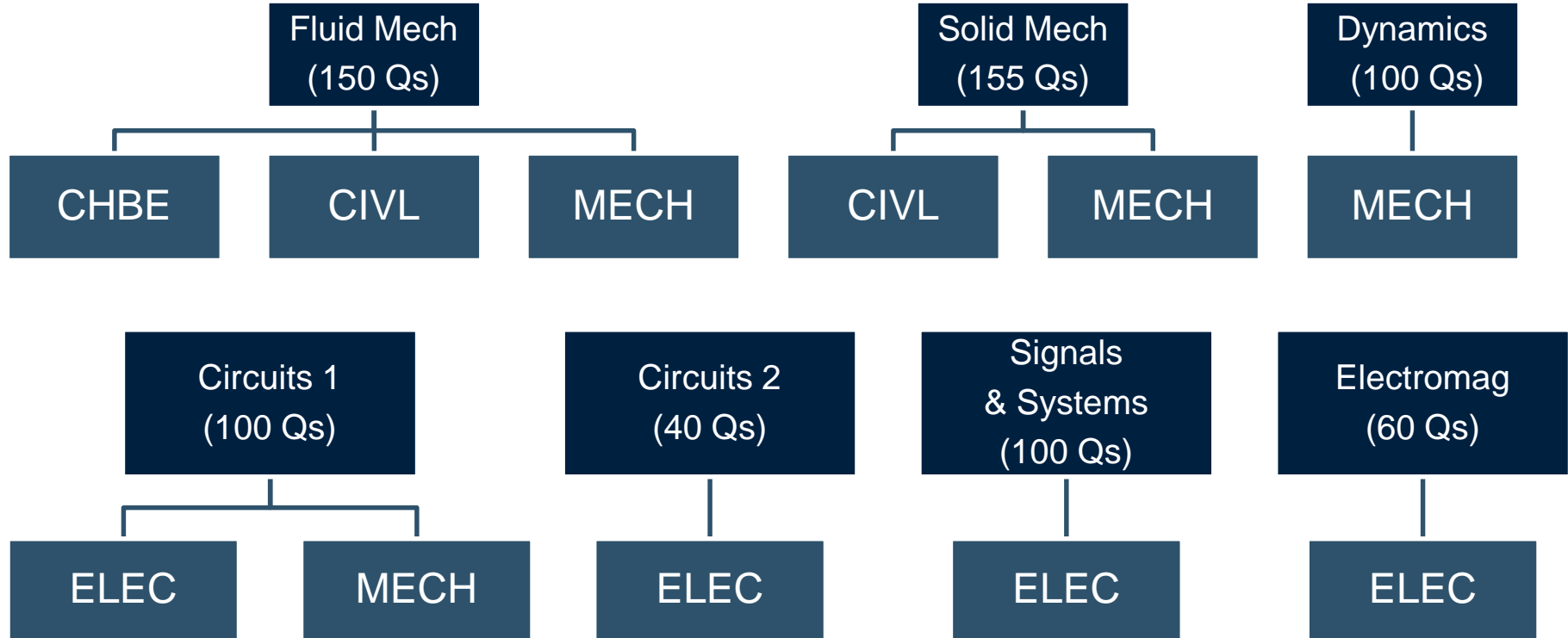
Mechanical Engineering  
(MECH)



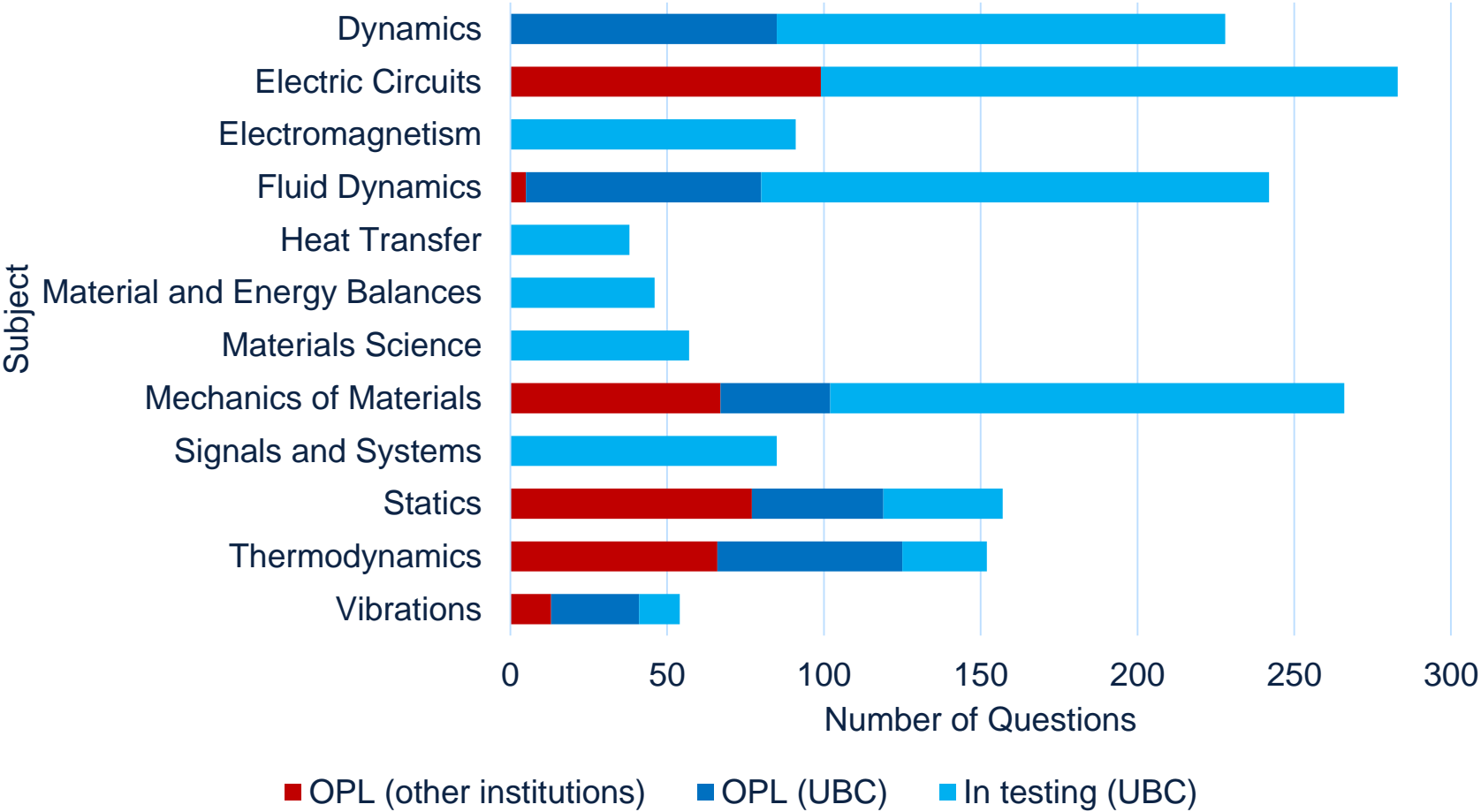
Chemical and Biological  
Engineering (CHBE)

# ENGINEERING YEAR 2 WEBWORK PROJECT

- UBC Teaching and Learning Enhancement Fund (TLEF) \$50,000
- BC Campus Open Educational Resources Grant Program \$7,500



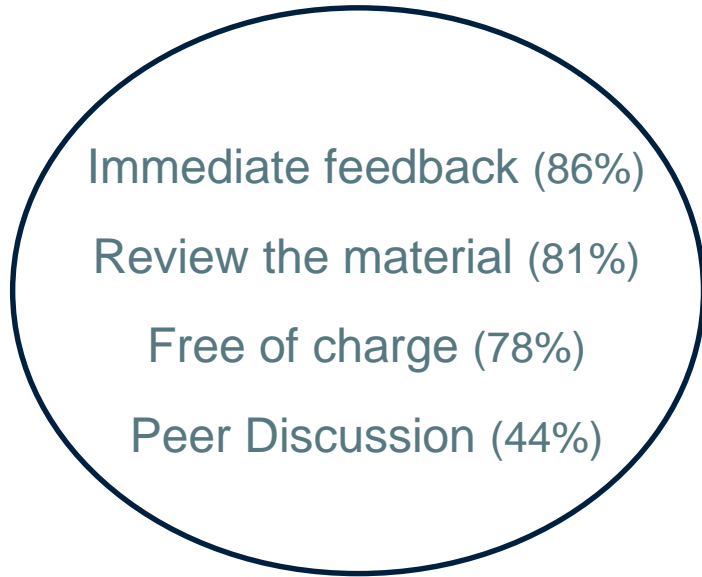
# ENGINEERING QUESTIONS IN THE OPEN PROBLEM LIBRARY (OPL)





# WHAT DO STUDENTS SAY ABOUT WEBWORK?

**87.7%\*** rated their experience with WeBWork as satisfactory



\*Survey of students in Electrical and Computer Engineering Department (ECE) at UBC

**92%\*\*** preferred WeBWork to other systems

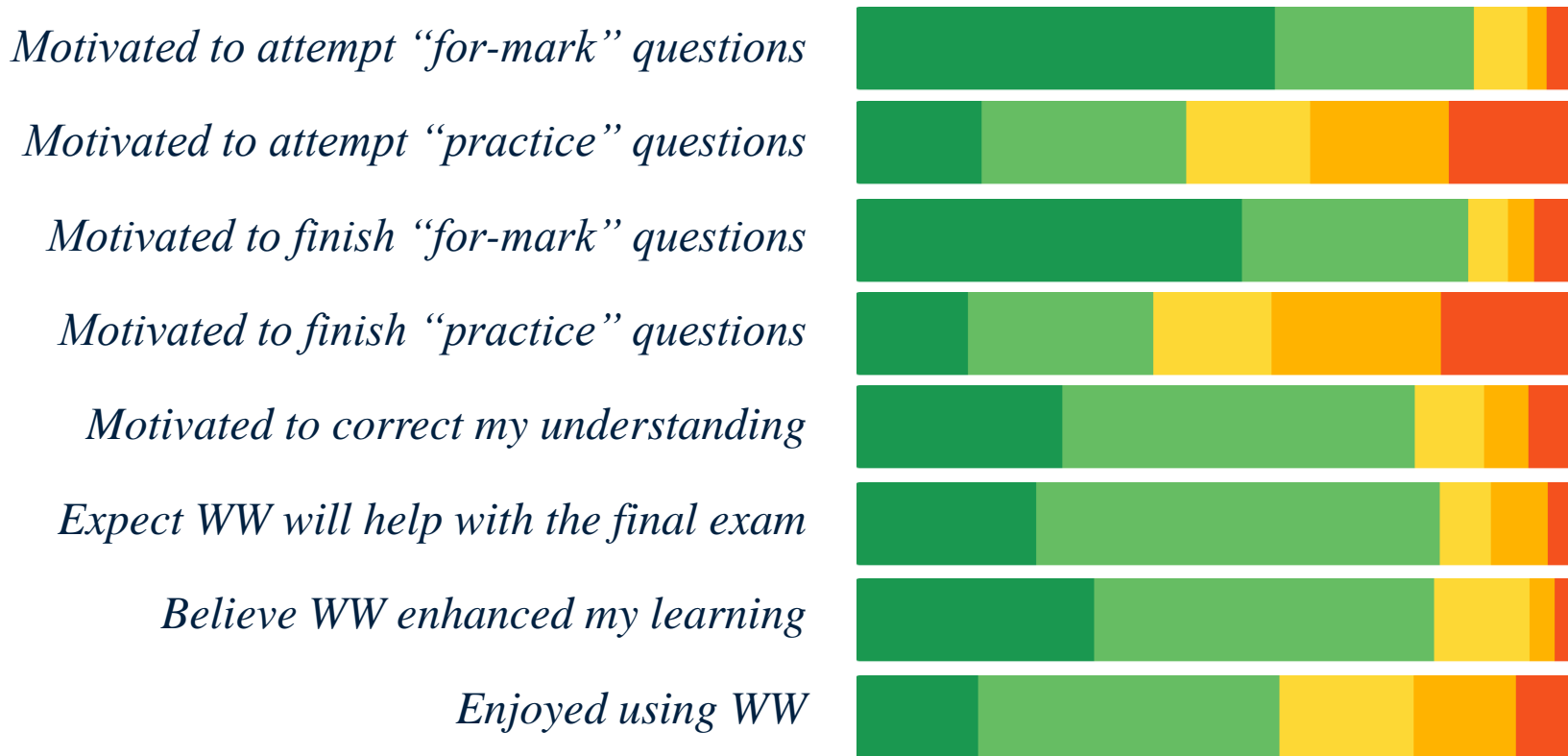
1 = Strongly disagree, 3 = Neutral, 5 = Strongly agree

Selected statements about specific tools	Ratings for Blackboard [mean (SD)]	Ratings for WeBWork [mean (SD)]
The <b>feedback</b> given through the tool was EASY TO ACCESS	1.7 (1.0)	4.4 (0.9)
The <b>feedback</b> given through the tool was CLEAR	1.9 (1.0)	4.2 (1.1)
The tool <b>enhanced my learning</b>	1.9 (1.0)	4.5 (0.7)
I would <b>like to use</b> the tool in the future	1.3 (0.6)	4.7 (0.6)

\*\*MECH students (d'Entremont, Canadian Engineering Education Association, 2017)

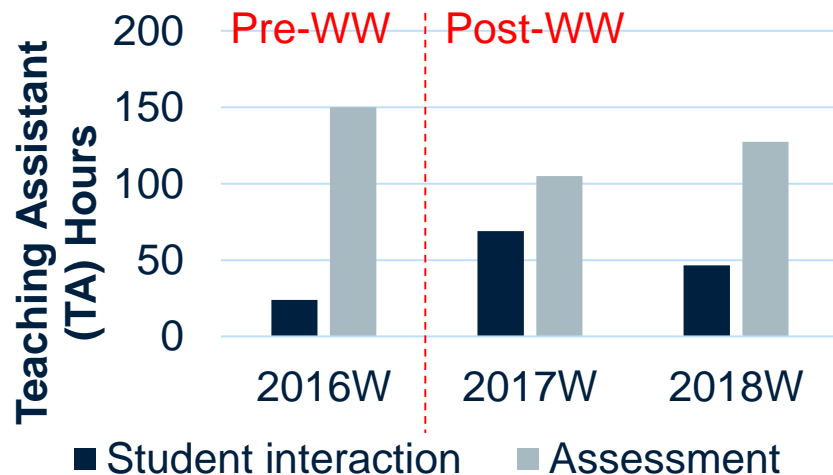
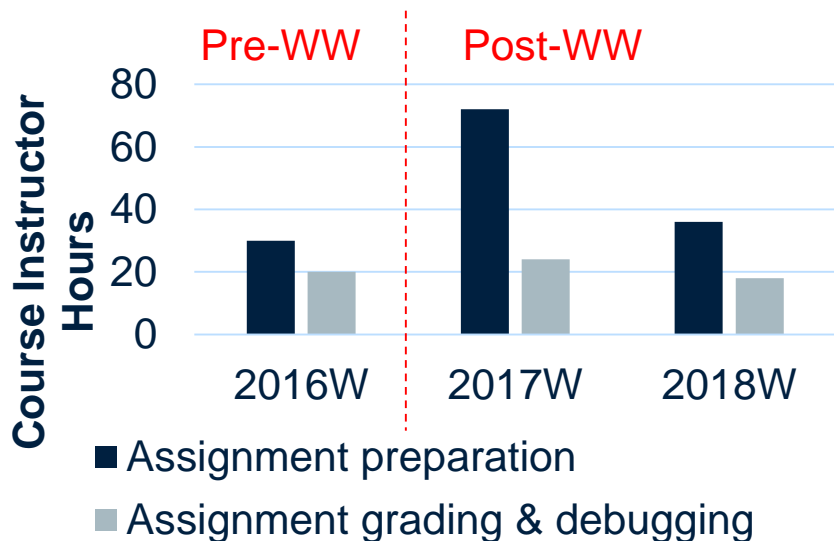
# STUDENT SURVEY RESULTS FROM THIS PROJECT (MULTIPLE DEPTS)

## How did WeBWork impact your studies this term?



## IMPACT ON INSTRUCTORS?

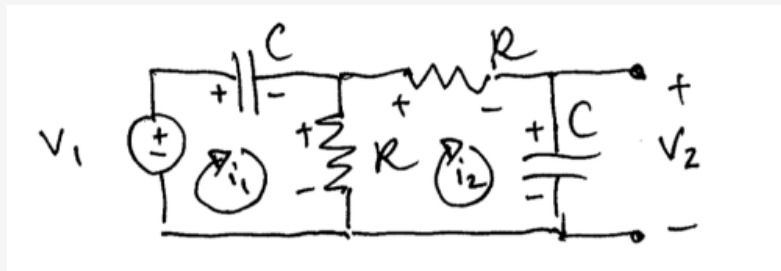
Impact on instructors in 2nd year CHBE course, WeBWork (WW) implemented in 2017W.



- More TA time spent on interacting with students through office hours, in tutorials.
- Significant time dedicated to question creation initially by instructors.

## A TYPICAL SAMPLE QUESTION

Consider the RLC circuit:



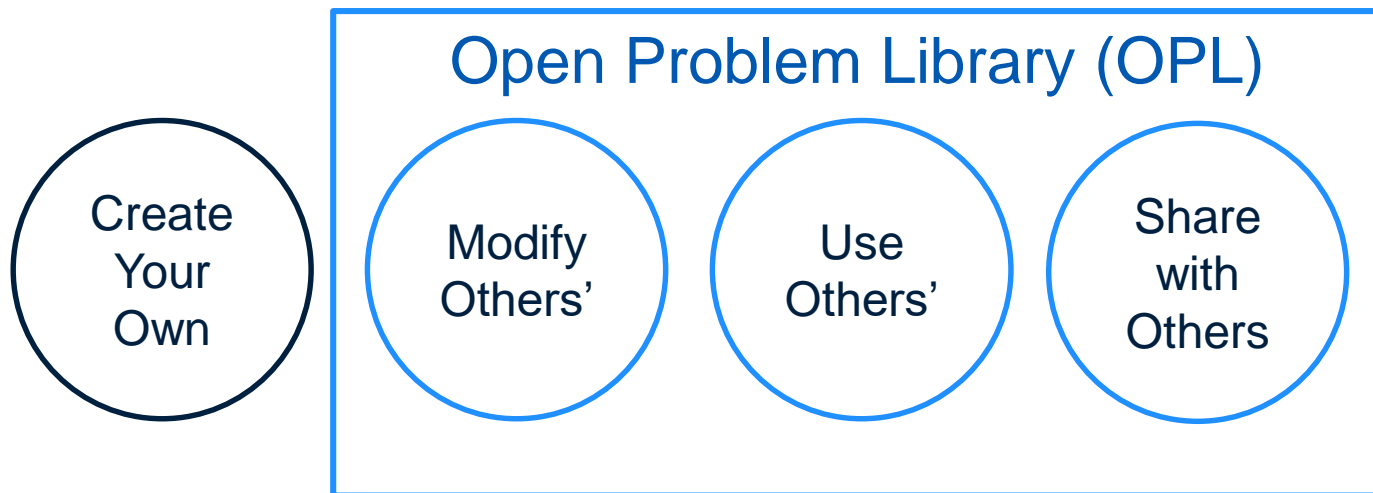
Find the transfer function  $H(s) = \frac{V_2(s)}{V_1(s)} =$

Suppose the components are  $R = 160\Omega$  and  $C = 0.18F$  and the input is  $v_1(t) = \sin(3t)$ .

Find the amplitude of the steady state response:

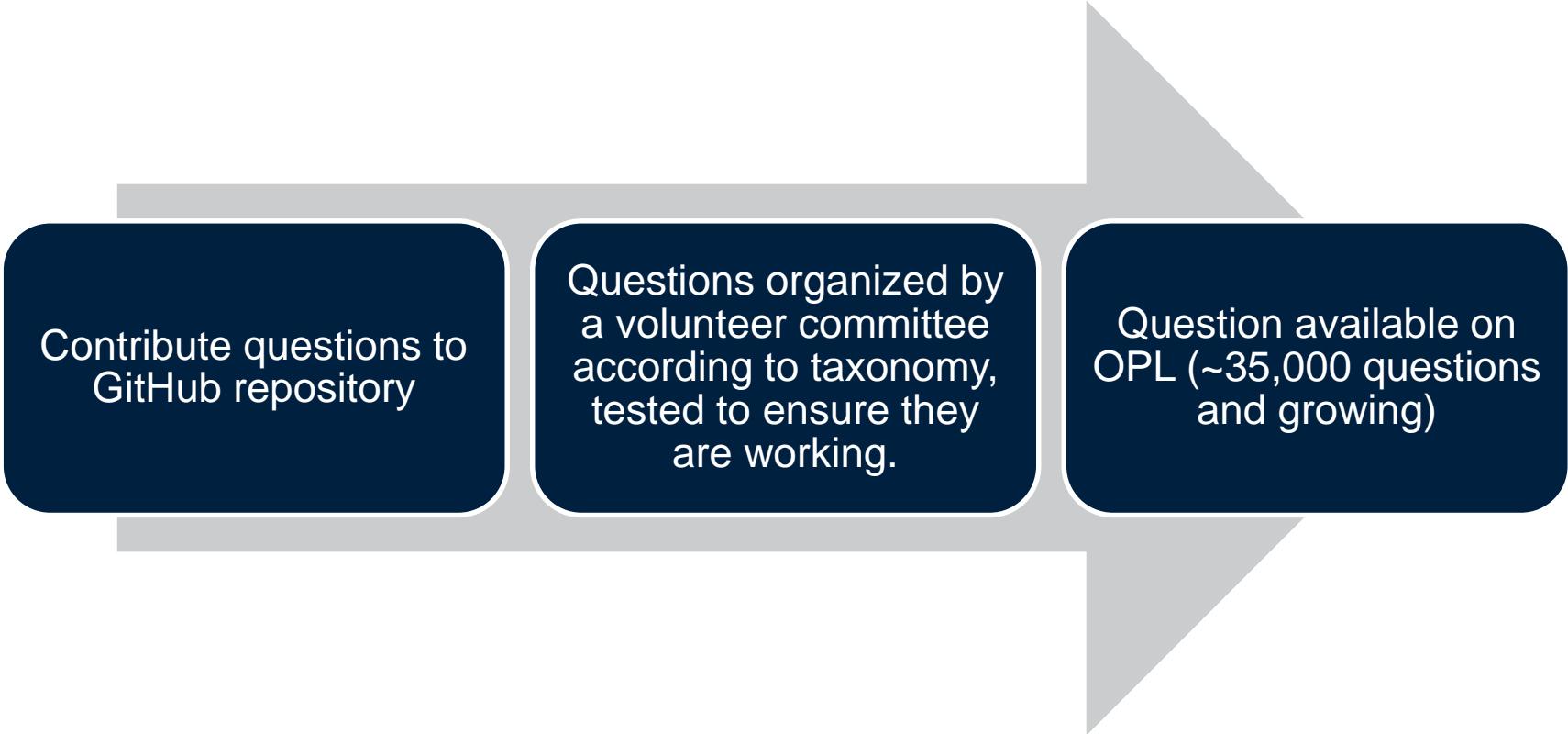
[https://webwork.elearning.ubc.ca/webwork2/APSC\\_TLEF/](https://webwork.elearning.ubc.ca/webwork2/APSC_TLEF/)

## WHERE TO START?



[webwork.maa.org/wiki](http://webwork.maa.org/wiki)

## CONTRIBUTING TO THE OPL



```
graph LR; A[Contribute questions to GitHub repository] --> B[Questions organized by a volunteer committee according to taxonomy, tested to ensure they are working.]; B --> C[Question available on OPL (~35,000 questions and growing)];
```

Contribute questions to  
GitHub repository

Questions organized by  
a volunteer committee  
according to taxonomy,  
tested to ensure they  
are working.

Question available on  
OPL (~35,000 questions  
and growing)

## OPPORTUNITIES

- Scripts for automated conversion of questions from other problem systems. Successfully done with Desire2Learn.
- Local or regional WeBWork community and users group
- Sharing scripts and resources: <https://github.com/ubc-mech2>

## CHALLENGES

- Time to create 1 problem: ~1.5-2 hours
- Getting the right tolerances for final answer (with the right variable ranges)
- Making shareable graphics
- Errors in code and correction of these



$\pm ?$



Error!



# ACKNOWLEDGEMENTS

## Collaborators

- Dr. Negar M. Harandi – UBC Electrical and Computer Engineering
- Gianni Co – UBC Mechanical Engineering

## Support provided by:

- UBC Teaching and Learning Enhancement Fund (TLEF)
- BCcampus
- UBC Centre for Teaching, Learning and Technology (CTLT)
- UBC Applied Science Centre for Instructional Support (APSC CIS)
- UBC Department of Mechanical Engineering
- UBC Department of Chemical & Biological Engineering
- UBC Department of Electrical & Computer Engineering

## QUESTIONS AND DISCUSSION?

Respond at **[www.slido.com](http://www.slido.com)**

with this code: **#B198**

Can ask questions here and up-vote questions

The logo for Slido, featuring the word "slido" in a bold, dark grey sans-serif font. The dot of the "i" is replaced by a solid green circle.

# BUILDING WEBWORK QUESTIONS



## WHAT TYPE OF QUESTIONS?

Consider the matrix  $A = \begin{bmatrix} 2 & 3 \\ 4 & 1 \end{bmatrix}$  and the matrix  $B = \begin{bmatrix} -1 & 2 \\ 2 & 1 \end{bmatrix}$ . What is  $A + B$ ?

- ☐ A.  $\begin{bmatrix} -2 & 6 \\ 8 & 1 \end{bmatrix}$
- ☐ B.  $\begin{bmatrix} 1 & 5 \\ 6 & 2 \end{bmatrix}$
- ☐ C.  $\begin{bmatrix} 2 & 1.5 \\ 2 & 1 \end{bmatrix}$
- ☐ D.  $\begin{bmatrix} 4 & 7 \\ -2 & 9 \end{bmatrix}$
- ☐ E. none of the above

## WHAT TYPE OF QUESTIONS?

Consider a circle of radius  $R = 4$  units.

a. What is the area of the circle?

b. What is the circumference of the circle?

c. What is the area of the largest square that fits inside the circle?

## WHAT TYPE OF QUESTIONS?

Let  $f(x, y, z) = 6xyz^3 + 3xy^2 + 9x^2yz + 1$ .

a. Compute the partial derivative  $\frac{\partial f}{\partial x} =$

b. Compute the partial derivative  $\frac{\partial f}{\partial y} =$

c. Compute the partial derivative  $\frac{\partial f}{\partial z} =$

## **Q & A / DISCUSSION**

- What are the advantages of using WeBWork for your course/program?
  - Do you feel confident that you can code appropriate problems?
  - What are the barriers to adopting WeBWork in your course/program?
  - Would you be willing to share problems via the OPL? What would make it easier or more attractive to do so?
- 
- Do you have questions for us?



# FINDING WEBWORK QUESTIONS



# Github.com, home of the Open Problem Library (OPL)

The screenshot shows the GitHub repository page for `openwebwork/webwork-open-problem-library`. The repository is described as "A library of WeBWork problem contributed by the OpenWeBWork community". It has 6,432 commits, 1 branch, 0 releases, and 53 contributors. The page includes navigation tabs for Code, Issues (5), Pull requests (9), Projects (0), and Insights. A recent commit by `jwj61` is highlighted, showing a merge of pull request #394. Below this, a table lists the repository's folders: `Contrib`, `OpenProblemLibrary`, and `Pending`, along with their descriptions and the time since the last update.

openwebwork / webwork-open-problem-library

Watch 32 Star 81 Fork 179

Code Issues 5 Pull requests 9 Projects 0 Insights

A library of WeBWork problem contributed by the OpenWeBWork community

6,432 commits 1 branch 0 releases 53 contributors

Branch: master New pull request Find file Clone or download


jwj61 Merge pull request #394 from chenhao6459new/master Latest commit e6c7e92 5 days ago

Contrib	Merge pull request #394 from chenhao6459new/master	5 days ago
OpenProblemLibrary	Fixed bug 4016.	10 days ago
Pending	Moving from pending	2 months ago

## Three main folders

- Contrib – new contribution to the OPL, problems automatically considered for OPL unless flagged not to be
- Open Problem Library – Problems that are also available on the OPL browser
- Pending – For problems being reviewed by OPL editorial board

# Each institution has its own folder on the Open Problem Library (OPL)

 [openwebwork](#) / [webwork-open-problem-library](#)

Watch 37

Star 101

Fork 194

<> Code

Issues 5

Pull requests 6

Projects 0

Wiki

Insights


Branch: master ▾ [webwork-open-problem-library](#) / [Contrib](#) /

Create new file















Upload files

Find file

History

 **d-torrance** Add additional hypothesis testing problems ...

Latest commit ea59d75 16 days ago

..		
 <a href="#">AlfredUniv</a>	Gigantic commit: regularizing loadMacros commands to start with PGSta...	8 months ago
 <a href="#">BCIT</a>	New folder for BCIT	3 months ago
 <a href="#">Berkeley</a>	Gigantic commit: regularizing loadMacros commands to start with PGSta...	8 months ago
 <a href="#">CAPA</a>	Gigantic commit: regularizing loadMacros commands to start with PGSta...	8 months ago
 <a href="#">CSUN</a>	Gigantic commit: regularizing loadMacros commands to start with PGSta...	8 months ago
 <a href="#">GRPS</a>	Gigantic commit: regularizing loadMacros commands to start with PGSta...	8 months ago
 <a href="#">Hope</a>	Fix answer checker errors	4 months ago
 <a href="#">JFreeman/Vectors</a>	Gigantic commit: regularizing loadMacros commands to start with PGSta...	8 months ago
 <a href="#">LaTech</a>	Gigantic commit: regularizing loadMacros commands to start with PGSta...	8 months ago
 <a href="#">MC/Proofs</a>	Gigantic commit: regularizing loadMacros commands to start with PGSta...	8 months ago
 <a href="#">METU-NCC</a>	Gigantic commit: regularizing loadMacros commands to start with PGSta...	8 months ago
 <a href="#">Michigan</a>	Add files for revised precalculus entrance gateway.	a year ago
 <a href="#">Mizzou</a>	Gigantic commit: regularizing loadMacros commands to start with PGSta...	8 months ago
 <a href="#">MontanaState</a>	Gigantic commit: regularizing loadMacros commands to start with PGSta...	8 months ago

(In upcoming Activity B4, you can create a school folder in Contrib if none existing currently)

# Library Browser

Add problems to **Target Set:**

Select a Set from this Course



Edit Target Set

Create a New Set in This Course:

Browse

Open Problem Library

Local Problems

From This Course

Set Definition Files

or Problems from

OPL Directory

Subject:

All Subjects



Advanced Search

Chapter:

All Chapters



Section:

All Sections



View Problems

Display Mode:

MathJax



Max. Shown:

20

☐

Hints

☐

Solutions

There are 33201 matching WeBWork problems

Add All

Clear Problem Display

# Library Browser

Add problems to **Target Set:**   Choose a problem set to add problems into

Or name a new one to be created

Browse      
or Problems from  Choose where to search

Subject:    
Chapter:   
Section:

Display Mode:   ☐ Hints ☐ Solutions

There are 33201 matching WeBWork problems Number of problems shown

The OPL has many problems (we see 33,201 listed at the bottom). We will use the advanced search (Subject, Chapter and section) to narrow this down

# Library Browser

Add problems to **Target Set:**

Browse

or Problems from

Subject:

Chapter:

Section:

Display Mode:

Max. Shown:

☐ Hints ☐ Solutions

There are 11 matching WeBWork problems

The OPL reduces the number of problems listed as we search by subject, chapter and section.

# Library Browser

Add problems to **Target Set:** Select a Set from this Course Edit Target Set

Create a New Set in This Course:

Select local problem sets to your institution

Browse Open Problem Library Local Problems From This Course Set Definition Files  
or Problems from OPL Directory

Local Problems: ubcLibrary/MECH2/set220SelfTest-Trusses

View Problems Display Mode: MathJax Max. Shown: 20 ☐ Hints ☐ Solutions

Add All Clear Problem Display

This will show problem sets in your course, as well as those shared through the your institution's OPL folders. Note this will also have problems from the contrib folder on the OPL.



# Library Browser

Add problems to **Target Set:**

Select a Set from this Course

Edit Target Set

Create a New Set in This Course:

Select course problem sets

Browse

Open Problem Library

Local Problems

From This Course

Set Definition Files

or Problems from

OPL Directory

Browse from:

Select a Homework Set

View Problems

Display Mode:

MathJax

Max. Shown:

20

☐

Hints

☐

Solutions

Add All

Clear Problem Display

This will show problem sets in your course only.

# Library Browser

Add problems to **Target Set:**

Create a New Set in This Course:

Select set definition files

Browse

or Problems from

Browse from:

Display Mode:

Max. Shown:

☐

Hints

☐

Solutions

Set definition files is a file format that can be used to share WeBWork problems between courses. This can be created in the “homework sets” menu under the “export” tab.

# GITHUB AND THE OPL



## WHY GITHUB?

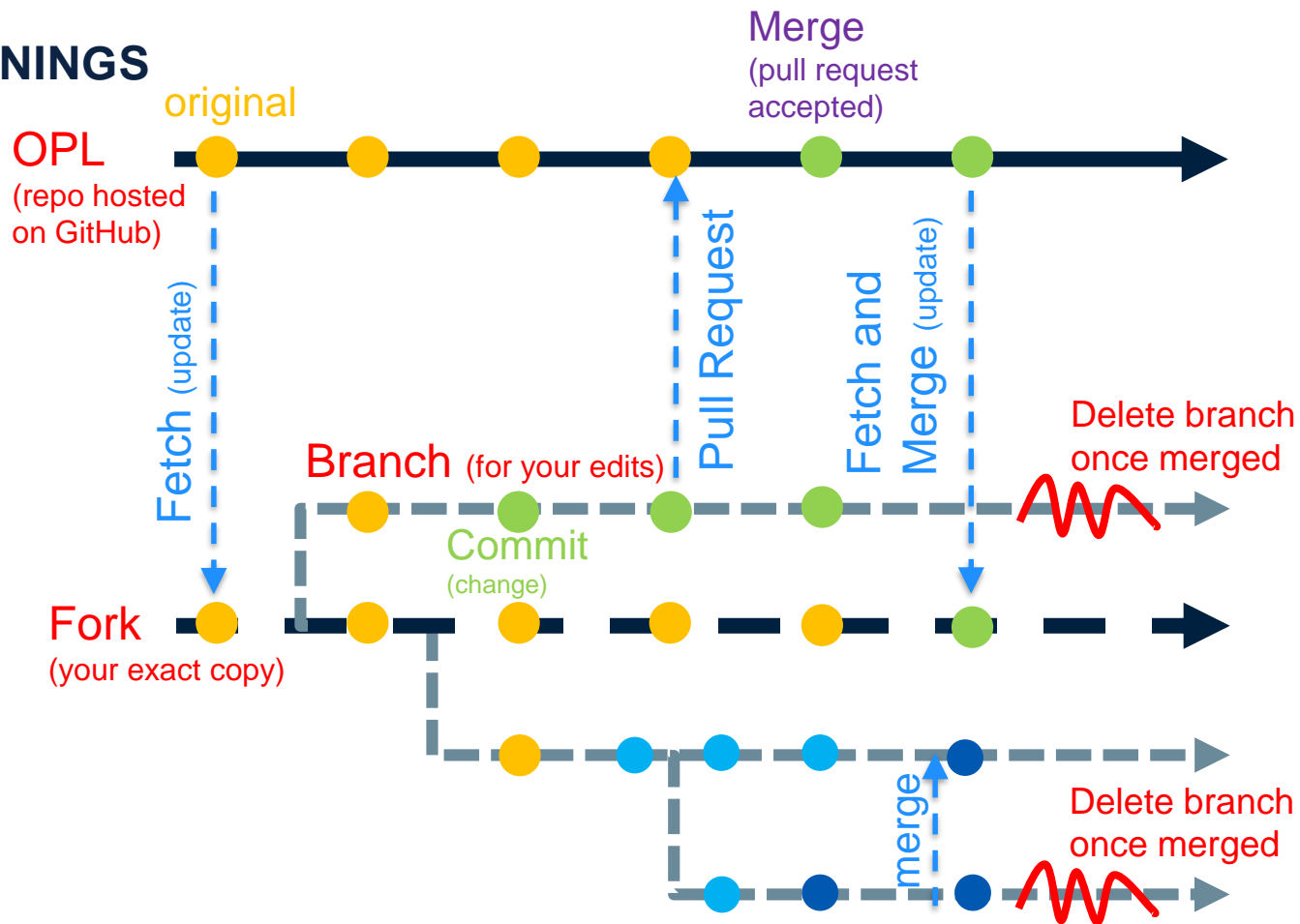
This is a WeBWork workshop – *why are we talking about GitHub?*

- The OPL is a public code repository (repo) on GitHub
- To contribute to the OPL, you need to submit your problems through GitHub
- We want instructors to create **and share** their problems

**(Note about copyright** – since the OPL is open source and available to anyone on the web, it's not very clear if coding and posting textbook problems would fall under fair dealing (i.e. access is not limited to your students). For this reason, we are creating original problems and images to share).

# TERMS AND MEANINGS

- Git
- GitHub
- Repo(sitory)
- Fork
- (Fetch)
- Branch
- Commit
- Pull request
- Merge








# TAXONOMY







How problems are categorized in OPL (allows browsing):

- **Subject** – Geometry
- **Chapter** – Angles
- **Section** – Bisectors


*(Aside: we've been creating engineering taxonomies – talk to us/see our talk ASEE session W138 Wed 8-9:30, Rm 252)*





 openwebwork / webwork-open-problem-library




 Watch  32  Star 81  Fork 180

 Code  Issues 5  Pull requests 9  Projects 0  Wiki  Insights

Branch: master [webwork-open-problem-library / OpenProblemLibrary / Taxonomy](#) [Find file](#) [Copy path](#)

 hjtrussell added Electrical Engineering to Taxo 002aa65 on Apr 14

4 contributors    

Executable File | 1043 lines (1042 sloc) | 24.2 KB [Raw](#) [Blame](#) [History](#)   

```
1 Calculus - single variable
2   Limits and continuity
3     Motivational applications (estimation)
4     Finding limits using graphs
5     Rules of limits - basic
6     Evaluating limits - factoring
7     Evaluating limits - rationalizing
8     Evaluating limits - rational expressions
9     Evaluating limits - trigonometric
10    Squeeze theorem
11    One-sided limits - concept of
12    Continuity - concept of
13    Continuity - classifying discontinuities
14    Continuity - intermediate value theorem
15    Infinite limits and vertical asymptotes
16    Limits at infinity, horizontal and oblique asymptotes
17    Estimating limits numerically
18    Applications - instantaneous rate of change
19    Applications - tangent lines and slopes
20    Applications - finding all asymptotes
21    Applications - other
22    Definitions and existence (conceptual)
23  Differentiation
24    Definition of the derivative
25    Conceptual understanding of derivatives
26    Derivatives of polynomials and power functions
27    Product rule (without trigonometric functions)
28    Product rule (with trigonometric functions)
29    Quotient rule (without trigonometric functions)
30    Quotient rule (with trigonometric functions)
```

... / Contrib / UBC / MECH / MECH2 / (course org)  
institution / course subject / specific course

## STRUCTURE

The screenshot shows the GitHub interface for the repository 'webwork-open-problem-library' by 'openwebwork'. The repository has 37 watches, 95 stars, and 189 forks. The 'Code' tab is selected, showing the file structure. The branch 'master' is active. The commit history shows a recent commit by 'adentremont' updating DB fields for all mechanics problems. The file structure includes folders for 'ECON/ECON325', 'MATH/MATH105', 'MECH/MECH2', 'SPPH/SPPH400', and 'STAT'.

openwebwork / webwork-open-problem-library

Watch 37 Star 95 Fork 189

Code Issues 5 Pull requests 6 Projects 0 Wiki Insights

Branch: master webwork-open-problem-library / Contrib / UBC /

Create new file Upload files Find file History

adentremont Updated DB fields for all mechanics problems Latest commit ee95f6d 20 days ago

..

ECON/ECON325	Gigantic commit: regularizing loadMacros commands to start with PGsta...	5 months ago
MATH/MATH105	Gigantic commit: regularizing loadMacros commands to start with PGsta...	5 months ago
MECH/MECH2	Updated DB fields for all mechanics problems	20 days ago
SPPH/SPPH400	Gigantic commit: regularizing loadMacros commands to start with PGsta...	5 months ago
STAT	update HW06/Q2	2 months ago

OR ... / Contrib / UBC / STAT / (problem org)  
institution / "set" Generalsubject





a place of mind

THE UNIVERSITY OF BRITISH COLUMBIA

THE UNIVERSITY OF BRITISH

