

- **STACK** = **S**ystem for **T**eaching and **A**ssessment using a **C**omputer algebra **K**ernel.
<http://stack.bham.ac.uk/moodle/question/type/stack/doc/doc.php/CAS/>
https://github.com/mathsmoodle-qtype_stack/blob/master/doc/en/index.md
- **MyCourses** is a Moodle-based virtual learning environment used at Aalto University.
<http://mycourses.aalto.fi/>
<https://wiki.aalto.fi/display/OPIT/MyCourses+Instructions+for+Teachers>
- **STACK** is implemented in **MyCourses** and is best used to generate homework assignments in which mathematics plays a role. The formulation of the assignments relies on elementary *LaTeX* skills when it comes to writing equations, and on *Maxima* when mathematical operations are carried out.
- For example, **STACK** may be used as follows:
 1. Generate a homework assignment with random numerical variables, say, a, b and c for a large number of students (for example, Solve for the value of x : $ax^2 + bx + c = 0$)
 2. Students carry out the relevant calculations and input their answers into MyCourses/STACK
 3. The results are **assessed and graded automatically** by STACK within MyCourses. Roughly speaking, STACK carries out the same calculations as the students to assess their answers.
- STACK provides plenty of options for formulating different types of tasks. The purpose of this guide is to facilitate the use of STACK by providing a simple example dealing with STACK's key elements. **In other words, this is a hands-on guide meant to provide food for thought and action.**
- In writing this piece, I have benefited from various guides and manuals for STACK and Maxima. Thanks.

Recommended actions after going through the example below:

Download and install Maxima (for free!) on your computer: <http://maxima.sourceforge.net/>

This is a fast way to learn by trial and error how to use Maxima. STACK uses Maxima but MyCourses is not the best environment for learning it.

Create an account at: <https://www.sharelatex.com/>

There is an easy-to-use LaTeX equation editor for STACK in MyCourses. However, if you want to go a step further, Sharelatex is an easy way to start using *LaTeX* to a larger extent. For example, ask from a colleague something written using LaTeX and upload the necessary source files as a zip to Sharelatex to get started.

Maxima operations require a bit more effort than LaTeX equations when using STACK. If you are familiar with Mathematica, Maple or Matlab, then Maxima is also a cakewalk.

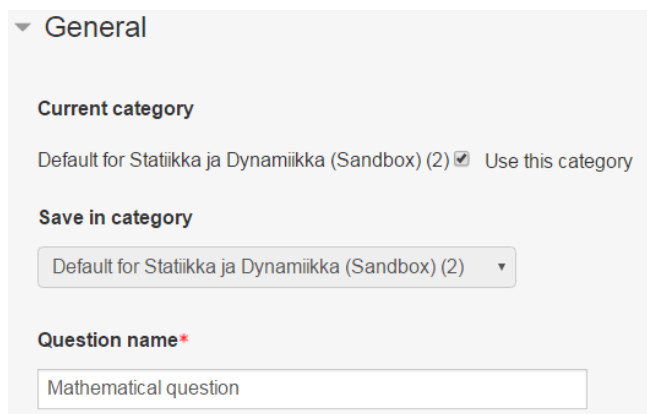
EXAMPLE – Solve for the value of x : $ax^2 + bx + c = 0$

Finding the tools in MyCourses

<http://mycourses.aalto.fi/> → Log in → My own courses → Select a course. If you don't have one, you may request a "Sandbox" course for yourself (only for teachers): [Link to form](#) → On the course page, go to Course Administration → Question Bank (Questions) → Create a new question → Scroll down, STACK → Add

Building the assignment

- We are in the Author's Statics and Dynamics sandbox.
- Enter **Question name**.
- **Question variables** field below contains the math relevant for the quadratic equation assignment at hand.
- Next fields are **Question text** & **Specific feedback & General feedback** (includes model solution).
- The above-mentioned fields have content that will be handled in **Inputs**, **Response trees** and **Options**.
- All the above **phases** relate to the formulation of the " $ax^2 + bx + c = 0$ " problem. After those, the problem is **Previewed** and, finally, **Activated** in MyCourses for the students.



Question variables ?	
<pre>/*This is a comment line*/ /*Random variables a, b, c for the task at hand*/ /*The random variables are activated later in the Question text field*/ /*a is a random integer; rand(n) generates an integer between 0 and n-1.*/ a:rand(6); /*b is a random integer but not same as a*/ b:rand_with_prohib(1,5,[a]); /*For c the value is one of those in the defined group. We could also include e.g. %pi*/ c:rand([-1, -2, -3]); /*We define a polynomial and its solution that will be used in our task*/ p:a*x^2+b*x+c; xs:solve(p=0,x) /*The VALUES of the solved roots are saved in x1 and x2.*/ x1exact:ev(x,xs[1]); x2exact:ev(x,xs[2]); /*We truncate the exact answer so that the the input by student should contain 3 significant figures, e.g. 2.67 or 0.345*/ x1:significantfigures(x1exact,3) x2:significantfigures(x2exact,3) /*The following refers to how many significant figures the model solution will show. "~4f" means 3 figures ("n-1")*/ stackfitfmt:"~4f"; /*We define a range for a figure in the Question text*/ min:round(min(x1,x2))-1 max:round(max(x1,x2))+1 /*Additional mathematical commands are documented in http://maxima.sourceforge.net/docs/manual/maxima.html*/</pre>	<p>/**/ signifies a comment line</p> <p>There are different ways to form random variables</p> <p>Google "stack random objects"</p> <p>The quadratic equation and its solution "xs"</p> <p>The exact values are saved</p> <p>What students have to answer</p> <p>This refers to the model solution</p> <p>Question text will include a figure using these values</p>

After defining the math, we compose the Question, and then the model solution in the Feedback part.

Question text* ? The equation editor can also be found here

$\frac{1}{x}$

A_1

B

I

A_2

$\frac{1}{x}$

$\frac{1}{x}$

$\frac{1}{x}$

$\frac{1}{x}$

$\frac{1}{x}$

$\frac{1}{x}$

$\frac{1}{x}$

$\frac{1}{x}$

/*This box uses Latex, e.g. we can write $\backslash(\text{equation})\backslash$ */

Solve

$\backslash\{(@p@)=0.\}$

You can estimate the location of the roots from the figure below

$\backslash\{\text{plot}(p,[x,\text{min},\text{max}])\}$

Plot gives e.g.

/*Answer fields:*/

Use THREE significant figures in your input, for example, 2.69 or 0.234.

$\backslash(x=\backslash)[[input:\text{ans1}]]$ or $[[validation:\text{ans1}]]$	
$\backslash(x=\backslash)[[input:\text{ans2}]]$	$[[validation:\text{ans2}]]$

/*Every answer field requires a validation which shows how the input is interpreted*/

Simplest LaTeX equation environments: $\backslash[\text{eq.}\backslash]$ $\backslash(\text{eq.}\backslash)$

Polynomial p was defined in the question variables and is activated here by using $\{(@p@)\}$


Input and validation for each answer


Correct inputs are defined later

Default mark* Total max score

3

Later ans1 can be set more valuable than ans2

Specific feedback 



A


▼


B


I


A


▼















/*The standard feedback is defined in the Response trees below*/


[[feedback:prt1]]











[[feedback:prt2]]

prt1 and prt2 refer to "potential response trees".

Correctness of answers ans1 and ans2, feedback on them and further actions will be handled in the trees.

Penalty  **Penalty for a wrong answer. Number of attempts and tips will be defined in Options.**

General feedback  **Penalty of 0.1 means 10% of the maximum points.**

/*This field may be used to explain the solution, for example.*/

Solution:

We solve the roots using

$$\sqrt{x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}}$$

and obtain

$\sqrt{x_1}$

$\sqrt{x_2}$

General feedback is given after the assignment is completed.

Here the model answer is given.

Input options, Response trees and other Options will be handled next.

Next the correct student input and the related options are defined.

‣ Input: ans1	Input type, model answers etc. are defined here
‣ Input: ans2	
‣ Potential response tree: prt1	Answers are checked in the response trees. Each answer/input can have its own tree or one tree can have multiple nodes to handle a number of inputs.
‣ Potential response tree: prt2	
‣ Options	Additional feedback and hints

▼ Input: ans1

Input type [?]

Model answer [?]

Input box size [?]

Strict syntax [?]

Insert stars [?]

Syntax hint [?]

Forbidden words [?]

Allowed words [?]

Forbid float [?]

Require lowest terms [?] <input type="text" value="No"/> if Yes Fractions have to be given in lowest terms e.g. 3/9 (incorrect) 1/3 (correct)	Check the type of the response [?] <input type="text" value="No"/> If yes, answers which are of a different "type" than the chosen "Algebraic" (e.g. expression, equation, matrix, list, set) are rejected as invalid.	Student must verify [?] <input type="text" value="Yes"/> Specifies whether the student's input is presented back to them as a forced two step process before this input is made available to the scoring mechanism.	Show the validation [?] <input type="text" value="Yes, with variable list"/> Displays any validation feedback from this input, including echoing back their expression in traditional two dimensional notation.	Extra options [?] <input type="text"/> Don't worry, see (?)
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In summary, there are a lot of options, but many of them are not needed in basic assignments. Short explanations can always be found under (?) which includes a link to more info (i).

Input 2 is similar to Input 1. Next we have Potential response tree: prt1 that assesses the answer 1.

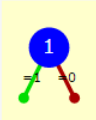
▼ Potential response tree: prt1

Question value Max points were 3. If question value is 1 for both trees, prt1 and prt2, each answer (ans1 and ans2) gives 1.5 points. Increasing the question value of prt1 increases the portion of ans1 from max points.

Auto-simplify Feedback variables can be used to prepare student answers for the response tree. For example, an answer can be modified so that it takes the value 1 or 0. Then in the tree "1" is correct and "0" not so.

Feedback variables

This potential response tree will become active when the student has answered: **ans1**



For the current example the relevant info is here. Instead of building a response tree with two nodes (one for each answer), we build separate trees for ans1 and ans2. This is convenient. In addition, if one node is left unanswered in a tree, the tree is not handled at all, which can be problematic.

Node 1 Answer test: SAns TAns Test options Quiet

Student answer Teacher answer

Node 1 when true The score must be a numeric value between 0 and 1. Keep 1. Feedback shown to students or not

Mod Score Penalty Next Answer note

Node 1 true feedback

First root is correct

Node 1 when false The score must be a numeric value between 0 and 1. Keep 1.

Mod Score Penalty Next Answer note

Node 1 false feedback


First root is incorrect


Add another node Instead of adding a node for ans2, we have response tree prt2 similar to prt1. prt3 could be created by [[feedback:prt3]]@Specific feedback (not needed).


Potential response tree: prt2


The following “Options” constitute our final section in formulating the problem.

Options

Question-level simplify 












Yes  **Keep**

Assume positive 

No  **Keep**












Standard feedback for correct

Feedback for the task. Specific prt1 and prt2 feedback will appear below these












Correct answer, well done. In more detail,

Standard feedback for partially correct















Your answer is partially correct. In more detail,

Standard feedback for incorrect

Completely incorrect answer. In more detail,

Multiplication sign  Surd for square root  Meaning and display of sqrt(-1)  Inverse trigonometric functions  Default shape of matrix parentheses  [Math related, controls mainly display](#)

Hint 1

$\frac{\square}{\square}$

B

I

$\frac{\square}{\square}$

There is a well-known solution for the quadratic equation at hand.

A hint is shown after an incorrect answer (ans1 or ans2 or both).

Hint 2

$\frac{\square}{\square}$

B

I

$\frac{\square}{\square}$

Use the force

The more hints there are, the more attempts the student has. Penalty was defined as 0.1 for each wrong answer.

Hint 3

$\frac{\square}{\square}$

B

I

$\frac{\square}{\square}$

Last change

Add another hint

Finally, click **SAVE CHANGES** button. Remember to save also during the assignment formulation.

If there are **errors** in the formulated assignment, STACK will keep you in the Editing section and show which fields include mistakes. For example, a complaint on *HTML formatted text* in a field is a common one even though there does not seem to be any HTML... In such a case just copy/pasting the content of the field into a notepad file and back to the field often works.

Preview

If everything is ok, you return to the Question bank, where the Assignment can be previewed:

Click **PREVIEW** and scroll down to the Attempt Options of the Preview:

Finally, the actual preview:

Question 1

Marked out of 3.0

Incomplete answer

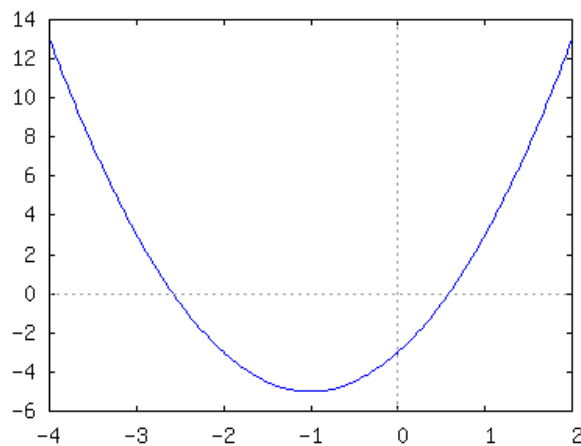
Solve

$$2 \cdot x^2 + 4 \cdot x - 3 = 0.$$

Tidy question | Question tests & deployed versions

Try these options

You can estimate the location of the roots from the figure below



Use THREE significant figures in your input, for example, 2.69 or 0.234.

$x =$ or

Your last answer was interpreted as follows:

-2.58

The correct would be 0.581

$x =$

Your last answer was interpreted as follows:

0.58

Please verify that what you entered was interpreted as expected.

Check

Press Check

Your answer is partially correct. In more detail,

First root is correct

Second root is incorrect

There is a well-known solution for the quadratic equation at hand.

Try again

Try again and input the correct answer 0.581 (THREE significant numbers)

Correct answer, well done. In more detail,

First root is correct

Second root is correct

Solution:

We solve the roots using

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

and obtain

−2.58

.581

**Model solution appears after
both roots are correct**

**If floats are forbidden
and the answer was,
say, square root of
two, then the input
would be typed in as
sqrt(2)**

A correct answer is −2.58, which can be typed in as follows:

A correct answer is .581, which can be typed in as follows:

The last line is relevant: 2.9/3.0 points due to penalty.

Response history (The grade was defined to have one decimal place, thus, 2.85~2.9)

Step	Time	Action	State	Marks
1	25/11/16, 10:26	Started	Tries remaining: 4	
2	25/11/16, 10:27	Saved: ans1: -2.58 [score]; ans2: 0.581 [score]	Tries remaining: 4	
3	25/11/16, 10:30	Submit: ans1: -2.58 [score]; ans2: 0.58 [valid]	Incomplete answer	
4	25/11/16, 10:33	Submit: ans1: -2.58 [score]; ans2: 0.58 [score]	Tries remaining: 3	
5	25/11/16, 10:34	Try again	Tries remaining: 3	
6	25/11/16, 10:34	Submit: ans1: -2.58 [score]; ans2: 0.581 [valid]	Incomplete answer	
7	25/11/16, 10:34	Submit: ans1: -2.58 [score]; ans2: 0.581 [score]	Correct	2.9

Our assignment formulation is complete. Next the assignment is **activated/deployed** in MyCourses:

1. Go to **Assignments** on the course page
2. Click **“Turn editing on”** on the right
3. Then click **“Add an activity or resource”** in the middle
4. Choose **Quiz** and **Add**
5. We are now in the general settings
6. Give a name for the assignment (**“Mathematical question”**)
7. Provide a brief **description** of the assignment (**“Find the roots of the quadratic equation”**).
8. The settings for the assignment follow. The actual assignment that was built will be chosen last.

Display description on course page
☒

The given description will be shown

Timing

Set the timing.

Open the quiz

13
December
2016
09
50
☐ Enable

Close the quiz

31
December
2016
09
50
☐ Enable

Time limit

0
minutes
☐ Enable

When time expires

Attempts must be submitted before time expires, or they are not counted

Submission grace period

0
minutes
☐ Enable

Grade

Grade category

Uncategorised

Grade to pass

0.00

Attempts allowed

2

Grading method

Highest grade

There are several options in the drop down menu. A grace period can be given for open attempts.

The gradebook can be found and managed on the course page under Course Administration. Students' points are saved in the gradebook automatically.

Every attempt may have multiple tries depending on the number of hints.

Better attempt is graded.

Layout

When there are multiple tasks, for example, in a weekly exercise set, each will appear on its own page with the chosen option.

New page

Every question
☐ Repaginate now

Navigation method*

Free

Navigation between the tasks is either Free or Sequential

10

Editing quiz: Mathematical question

Questions: 1 | Quiz open (closes 31/12/16, 09:50)

We can add multiple tasks/questions to the Quiz here. Then the max grade could be, for example, "5". The grade is calculated on the basis of the sum of the points from all tasks.

Repaginate

Grade
Maximum grade: 3.00 **Save**




Total of marks: 3.00

☐ Shuffle

Page 1 Add question

Points / Marks

1

Mathematical question /*This box uses LaTeX, e.g. we can write \[equation\]^* / Solve \[p@]=0. You can estimate the location of the   3.00 

Add question

Choose Maximum grade and **Save**. Go back to Assignments and click the assignment at hand to obtain:

Mathematical question

Find the roots of the quadratic equation.

Attempts allowed: 2

This quiz opened at Tuesday, 13 December 2016, 9:50 AM

This quiz will close at Saturday, 31 December 2016, 9:50 AM

Grading method: Highest grade

Preview quiz now

The preview would be similar to that above. Students go straight to the problem (no preview).

Concluding remarks

- It is possible to add figures to the assignments through the **Question** and **Feedback fields**. These fields also include other useful options.
- If you choose to use STACK on a course, you may want **test it** at the beginning of your course with some “pre-assignment”, for example, the quadratic equation. This provides a hands-on **tutorial** for the students on the use of STACK on their part, and helps you to check that the grading and gradebook work the way you want them to.
- **Suggested homework**: Make sure in the **Question variables** that **x1** and **x2** correspond to the smaller and higher value, respectively, and modify the question text accordingly.
- The Question bank in MyCourses has import/export capabilities. Sharing is caring: <https://abacus.aalto.fi/>