



Maple Flow™

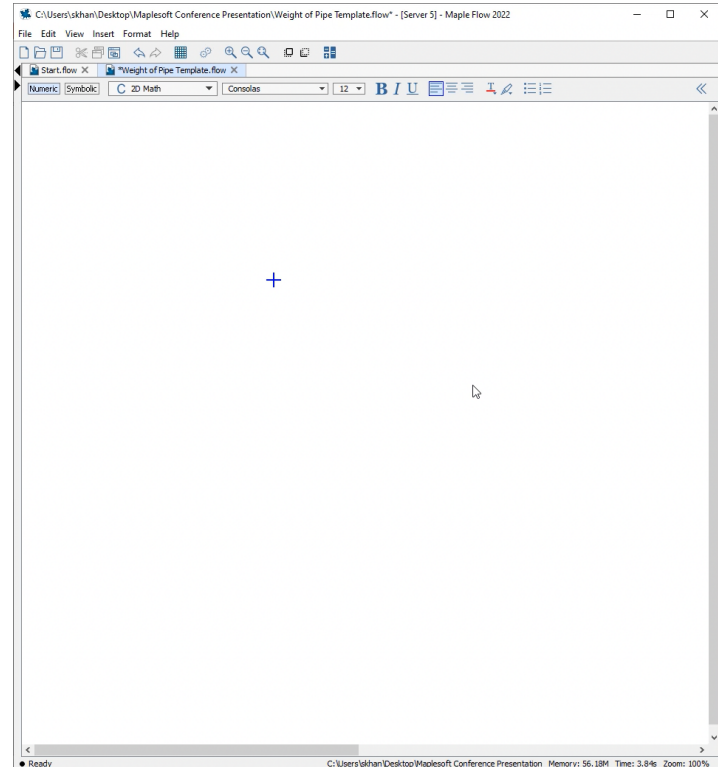
A Calculation Tool for Scientists and Engineers

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Maple Flow

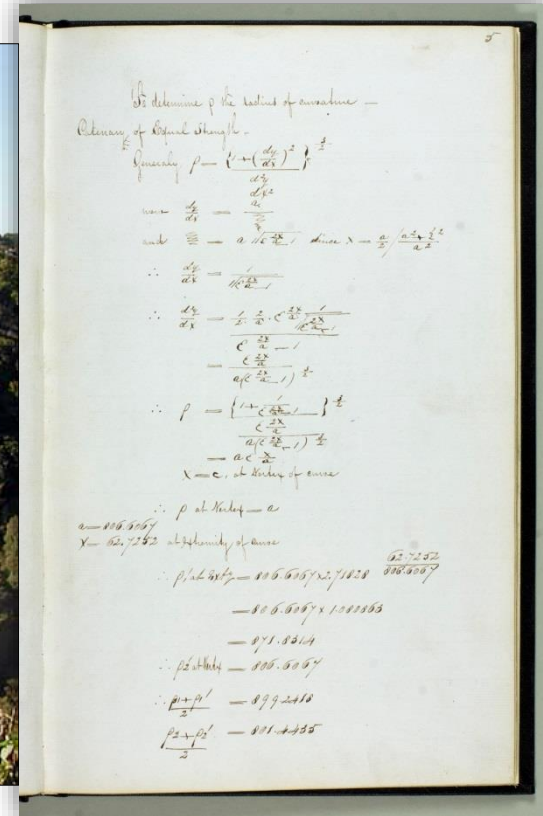
Simple, freeform tool for calculations and documentation

For design engineers and scientists



Engineering Calculations in the 1800s

Clifton Suspension Bridge
 Designed by Isambard Kingdom Brunel
 Opened in 1864



Features

- Place math, text, images and plots anywhere and move into position
- Left-to-right, top-to-bottom evaluation
- Automatic calculation updates
- Natural math notation and units
- Access to nearly all of Maple's math functionality

C:\Users\skhan\Desktop\Maplesoft Conference Presentation\acoustic location.flow* - [Server 11] - Maple Flow 2022

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Maple Flow www.maplesoft.com

Determine the Position of a Gunshot Through Acoustic Localization and Time of Arrival

The location of a gunshot is at an unknown point (x, y) . Three listening stations are placed at positions $(X[i], Y[i])$ where $i=1..3$.

The sound of the gunshot reaches the first listening station at time $t[1]=0$. If the distance from the cannon to the first listening station is R , then

$$(X[1] - x)^2 + (Y[1] - y)^2 - (R + t[1] \cdot a)^2 = 0 \quad (1)$$

where a is the speed of sound.

If the sound reaches the 2nd and 3rd microphones at times $t[2]$ and $t[3]$, then

$$(X[2] - x)^2 + (Y[2] - y)^2 - (R + t[2] \cdot a)^2 = 0 \quad (2)$$
$$(X[3] - x)^2 + (Y[3] - y)^2 - (R + t[3] \cdot a)^2 = 0 \quad (3)$$

These are three equations in three unknowns, (x, y) and R . This application determines position of the gunshot via two methods.

- 1) Minimization of the least squares error of equations 1, 2 and 3. This method is suitable if there is some uncertainty in the recorded times and positions of the listening stations
- 2) Numerical solution of equations 1, 2 and 3

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What this means for you

You don't have to start with a grand plan

Progressive refinement is rewarded

Smooth flow from initial calculation
concept to final technical report

C:\Program Files\Maple 2021\toolbox\MapleFlow\data/examples\HighwayPavementDesigning\CALTRANSmethod.flow" - (Server 4) - Maple Flow ...

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Highway Pavement Design using the CALTRANS method

A highway pavement is several layers of materials above the natural soil.

This application helps you design a flexible pavement using the approach outlined in the [Highway Design Manual](#) (6th edition) published by the California Department of Transportation (CALTRANS). Specifically, this application will determine the thickness of the subbase, base and asphalt concrete layers.

R-Value	"a measure of resistance of soils to deformation under wheel loading and saturated soils conditions"
Gravel Equivalent	"equivalent thickness of gravel (aggregate subbase) that would be required to prevent permanent deformation in the underlying layer or layers due to cumulative traffic loads anticipated during the design life of the pavement structure"
Traffic Index	"a measure of the cumulative number of ESALs expected during the design life of the pavement structure"
Annual Average Daily Traffic	"average 24-hour volume, being the total number during a stated period divided by the number of days in that period"
Equivalent Single Axle Loads	"number of 18-kip standard single axle load repetitions that would have the same damage effect to the pavement as an axle of a specified magnitude and configuration"

Excerpts from HDM 6th edition

Function to round lengths to the next highest: 0.05 ft

$$\text{roundhigh} := x \rightarrow \text{ifelse}(\text{frac}(10 \cdot x) > 0.5, 0.1 \cdot \text{ceil}(10 \cdot x), 0.1 \cdot \text{floor}(10 \cdot x) + 0.5)$$

California R-value of the material Gravel equivalent factor of structural layers

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Demo

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Start Flow X Untitled (32) X

Numeric Symbolic 2D Math Segoe UI 11 B I U

gas := "N2"

State 1

Pressure $P_1 := 2 \times 10^6 \text{ Pa}$

Temperature $T_1 := 900 \text{ K}$

Internal energy $u_1 = 6.921 \times 10^5 \frac{\text{J}}{\text{kg}}$

Specific volume $v_1 = 0.135 \frac{\text{m}^3}{\text{kg}}$

State 2

Pressure $P_2 := 7 \times 10^6 \text{ Pa}$

Temperature $T_2 := T_1 = 900 \text{ K}$

Internal energy $u_2 = 6.901 \times 10^5 \frac{\text{J}}{\text{kg}}$

Specific volume $v_2 := 1/\text{ThermophysicalData:-Property}(\text{density, gas, } T = T_2, P = P_2) = 0.039 \frac{\text{m}^3}{\text{kg}}$

Pressure at any specific volume $P := \text{ThermophysicalData:-Property}(\text{"pressure", gas, "temperature"} = T_1, "D" = 1/V)$

Work done in isothermal compression $w := \int_{v_1}^{v_2} P \, dV = -3.35 \times 10^2 \frac{\text{kJ}}{\text{kg}}$

Heat transferred per unit mass $q := u_2 - u_1 + w = -3.37 \times 10^2 \frac{\text{kJ}}{\text{kg}}$

Ready

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What This Means In The Classroom

- In the classroom
 - Develop mathematically live class notes and electronic hand-outs
 - Give students a clear understanding of the physics by exposing the equations in a readable format
 - Emphasize the importance of units
- Homework & Assignments
 - Give students a simple, freeform scratchpad for doing fully documented calculations
 - Help students spot and correct errors
 - Make calculations fun!

C:\Program Files\Maple Flow 2023\data\examples\DerivingBeamDeflectionEquations.flow* - [Server 4] - Maple Flow 2023

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Deriving Beam Deflection Equations

This application demonstrates how you can solve the Euler-Bernoulli equation to symbolically derive beam deflection equations for several different cases.

Point loads can be represented by the Dirac Delta function, while distributed loads can be represented by the Heaviside Step function.

Various combinations of initial and boundary conditions can be used to represent simple supports, cantilevers and free ends.

The cases given below can be extended to model other configurations.

Beam with Point Load

Euler-Bernoulli equation $de := EI \frac{d^4}{dx^4} w(x) = q(x)$

Initial and boundary conditions $ibc := w(0) = 0, w(L) = 0, w''(0) = 0, w''(L) = 0$

Load profile $q := x \cdot F \cdot \text{Dirac}(x - a)$

Solve the differential equation $deflection := dsolve(\{de, ibc\}, w(x))$

Convert Heaviside to piecewise $deflection := simplify(\text{convert}(deflection, \text{piecewise}, x)) \text{ assuming } L > a, \text{ positive} = w(x) =$

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Questions

