

Mathcad 15.0 Truenumbers-Integration_3

Flue Gas Analysis:

- Steam generator outlet (ASME 14):**
 - O₂ = 3.20% Excess oxygen measured at the steam generator outlet
 - CO = 80ppm CO measured at the steam generator outlet
 - NO_x = 333ppm NO_x at the steam generator outlet
 - P_{fg} = -2.0 in_{vac} static pressure (draft)
 - T_{fg} = 620P gas temperature
- Select the measurement basis for the gas samples:
 - Excess Air O₂Basis = Wet Basis Dry Basis
 - Flue gas emissions: NOTE: only emissions on the same basis (wet or dry) are handled by this form
 - Emissions Basis = Wet Basis Dry Basis
 - Emissions Ref = O₂ CO₂
- Excess air at the steam generator outlet:
 - X_{pA14} = ExcessAir/O₂·O₂Basis
 - X_{pA14} = 20.53%

Air weight: M_{qA} = 862.61 $\frac{\text{lb}}{\text{MBTU}}$

Flue gas weight: M_{qFg} = 901.95 $\frac{\text{lb}}{\text{MBTU}}$

Flue gas moisture: M_{pwFg} = 12.20%

Molecular weight of flue gas: M_{wFg} = 27.51 $\frac{\text{lb}}{\text{mol}}$

Flue gas density: ρ_{Fg} = 0.0347 $\frac{\text{lb}}{\text{ft}^3}$

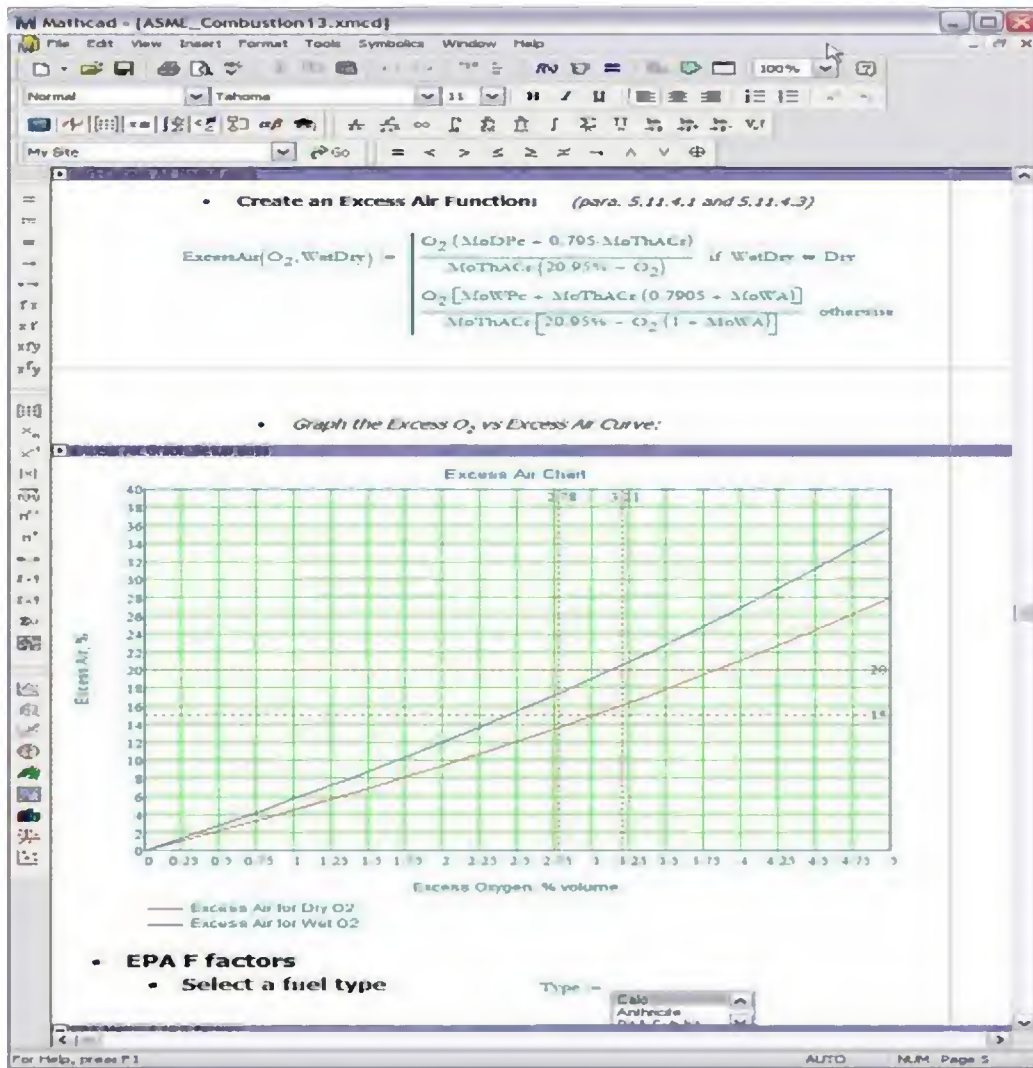
Emissions Rates

- NO_x emissions rate: E_{NO_x} = 0.40 $\frac{\text{lb}}{\text{MBTU}}$
- CO emissions rate: E_{CO} = 0.07 $\frac{\text{lb}}{\text{MBTU}}$

Mathcad 15.0 Truenumbers-Integration_3

– Truenumbers von True Engineering Technology bietet die Möglichkeit, Werte ohne Beeinträchtigung der Mengen- oder Einheitsintegrität anwendungs- und organisationsübergreifend auszutauschen. Ergebnisse und Werte können aus Mathcad in unterschiedliche Dokumenttypen verschoben werden, wodurch die gemeinsame Nutzung der Daten ermöglicht wird.

Mathcad 15.0 Truenumbers-Integration_2



Mathcad 15.0 Truenumbers-Integration_2

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Mathcad 15.0 Truenumbers-Integration

Determine the base air density refer to ASME PTC4-1998 for the background.

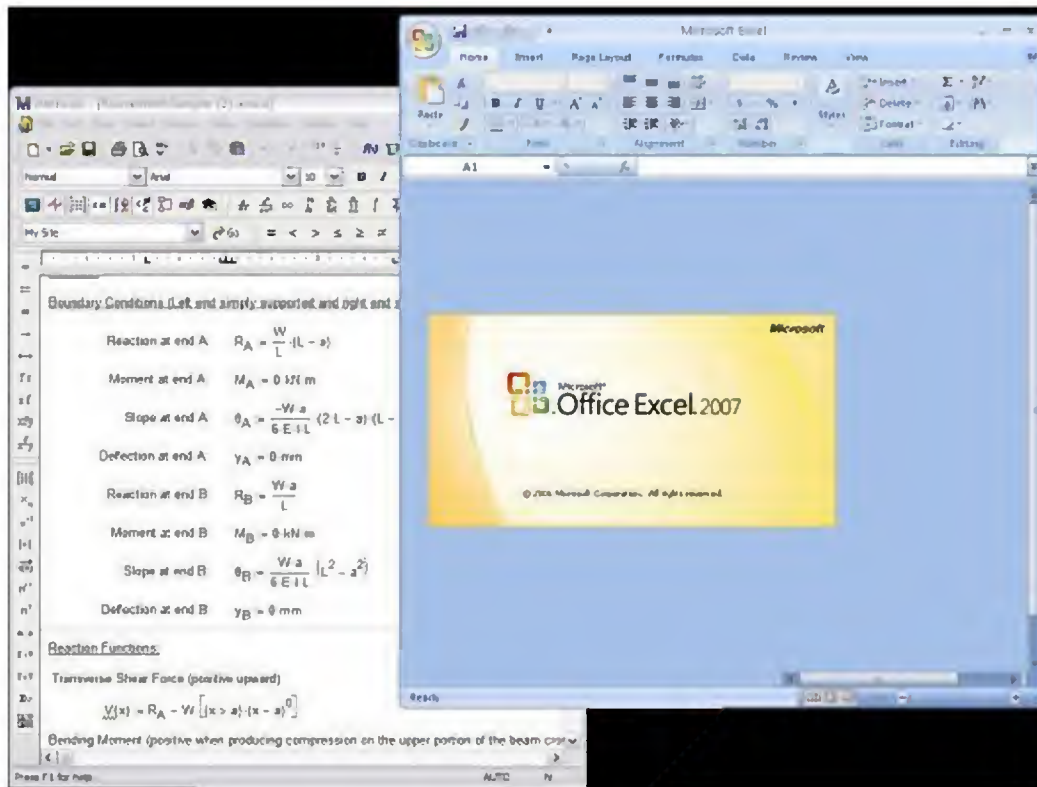
- Ambient atmospheric conditions:**
 - $P_{\text{baro}} = 29.92 \text{ in_Hg}$ (barometric pressure, in. Hg.)
 - $T_{A6} = 77 \text{ F}$ (air temperature, dry bulb at test location)
 - $R_{\text{hum}} = 65\%$ (relative humidity, at test location)
- Air density function with pressure and temperature corrections:**

$$\rho_{\text{Air}}(0_{\text{in_wc}}, T_{A6}) = 0.0733 \frac{\text{lb}}{\text{ft}^3}$$
- Fuel Analysis: (mass percent basis, as-received)**
 - Selected Fuel =
 - $Mp_{\text{CF}} = (\text{Fuel_Data}(\text{Selected_Fuel})_1) \%$ Carbon $Mp_{\text{CF}} = 71.34\%$
 - $Mp_{\text{H2F}} = (\text{Fuel_Data}(\text{Selected_Fuel})_2) \%$ Hydrogen $Mp_{\text{H2F}} = 28.41\%$
 - $Mp_{\text{SF}} = (\text{Fuel_Data}(\text{Selected_Fuel})_3) \%$ Sulfur $Mp_{\text{SF}} = 0.28\%$
 - $Mp_{\text{N2F}} = (\text{Fuel_Data}(\text{Selected_Fuel})_4) \%$ Nitrogen $Mp_{\text{N2F}} = 0.06\%$
 - $Mp_{\text{O2F}} = (\text{Fuel_Data}(\text{Selected_Fuel})_5) \%$ Oxygen $Mp_{\text{O2F}} = 0.16\%$
 - $Mp_{\text{WF}} = (\text{Fuel_Data}(\text{Selected_Fuel})_6) \%$ Fuel moisture $Mp_{\text{WF}} = 0.00\%$
 - $Mp_{\text{AF}} = (\text{Fuel_Data}(\text{Selected_Fuel})_7) \%$ Ash $Mp_{\text{AF}} = 0.00\%$
 - $Mp_{\text{CF}} + Mp_{\text{H2F}} + Mp_{\text{SF}} + Mp_{\text{N2F}} + Mp_{\text{O2F}} + Mp_{\text{WF}} + Mp_{\text{AF}} = 100.25\%$
- Heating Values:**
 - $\text{HHV}_{\text{Fcv}} = (\text{Fuel_Data}(\text{Selected_Fuel})_8) \frac{\text{BTU}}{\text{lb}}$ Higher heating value, constant volume
 - $\text{HHV}_{\text{F}} = \text{HHV}_{\text{Fcv}} - \left[2.664 \frac{\text{BTU}}{\text{lb}} (Mp_{\text{H2F}} 100) \right]$
 - $\text{HHV}_{\text{F}} = 25420 \frac{\text{BTU}}{\text{lb}}$ Converted to constant pressure
- Carbon Correction due to UBC**

Mathcad 15.0 Truenumbers-Integration_1

– Truenumbers von True Engineering Technology bietet die Möglichkeit, Werte ohne Beeinträchtigung der Mengen- oder Einheitsintegrität anwendungs- und organisationsübergreifend auszutauschen. Ergebnisse und Werte können aus Mathcad in unterschiedliche Dokumenttypen verschoben werden, wodurch die gemeinsame Nutzung der Daten ermöglicht wird.

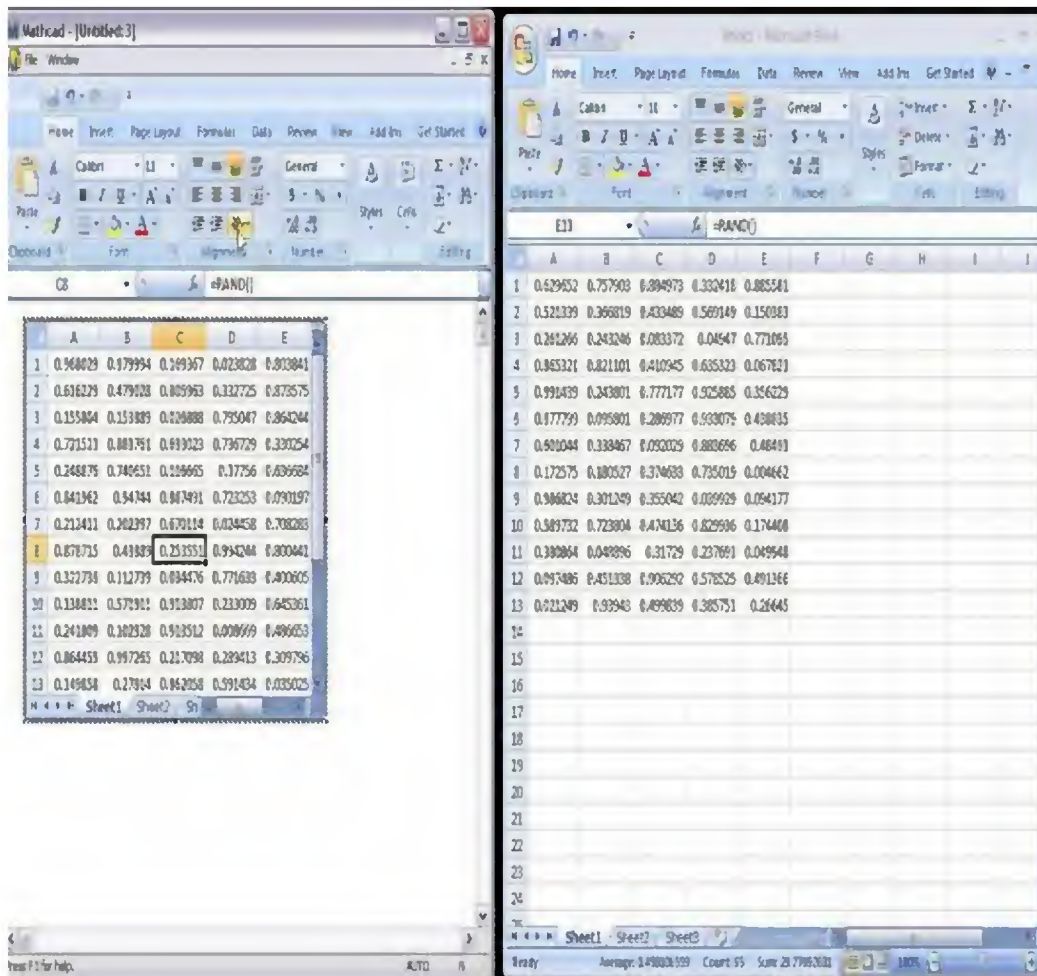
Mathcad 15.0 Unterstützung für die neueste Version von Microsoft Excel®_4



Mathcad 15.0 Unterstützung für die neueste Version von Microsoft Excel®_4

– Nutzen Sie die folgenden Funktionen und Leistungsmerkmale von Excel: READEXCEL(), WRITEEXCEL(), READFILE, den Datenimport-Assistenten und das Excel-Add-In

Mathcad 15.0 Unterstützung für die neueste Version von Microsoft Excel®_3



Mathcad 15.0 Unterstützung für die neueste Version von Microsoft Excel®_3

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Mathcad 15.0 Unterstützung für die neueste Version von Microsoft Excel®_2

Mathcad Resources: Using the Excel Component

Home Insert Page Layout Formulas Data Review View Add-Ins Get Started

Clipboard Font Alignment Number Styles Cells Editing

C1

In 1848 Rudolph Wolf devised a daily method of estimating solar activity by counting the number of individual spots and groups of spots on the face of the sun. The Excel spreadsheet shown contains annual totals of sunspots from 1700 to 1995.

years	A	B
10	1706	29
11	1707	20
12	1708	10
13	1709	8
14	1710	3
15	1711	0
16	1712	0
17	1713	2
18	1714	11
19	1715	27

Tip: Double-click on the Excel component to activate it in-place. Activating the component opens the Excel environment to allow you to edit the data.

Tip: To change the component's properties, right-click on it then choose Properties from the menu.

Once this data has been embedded in your Mathcad worksheet, you can use it as you would data or variables that are native to the worksheet itself.

Annual Sunspot Count

counts

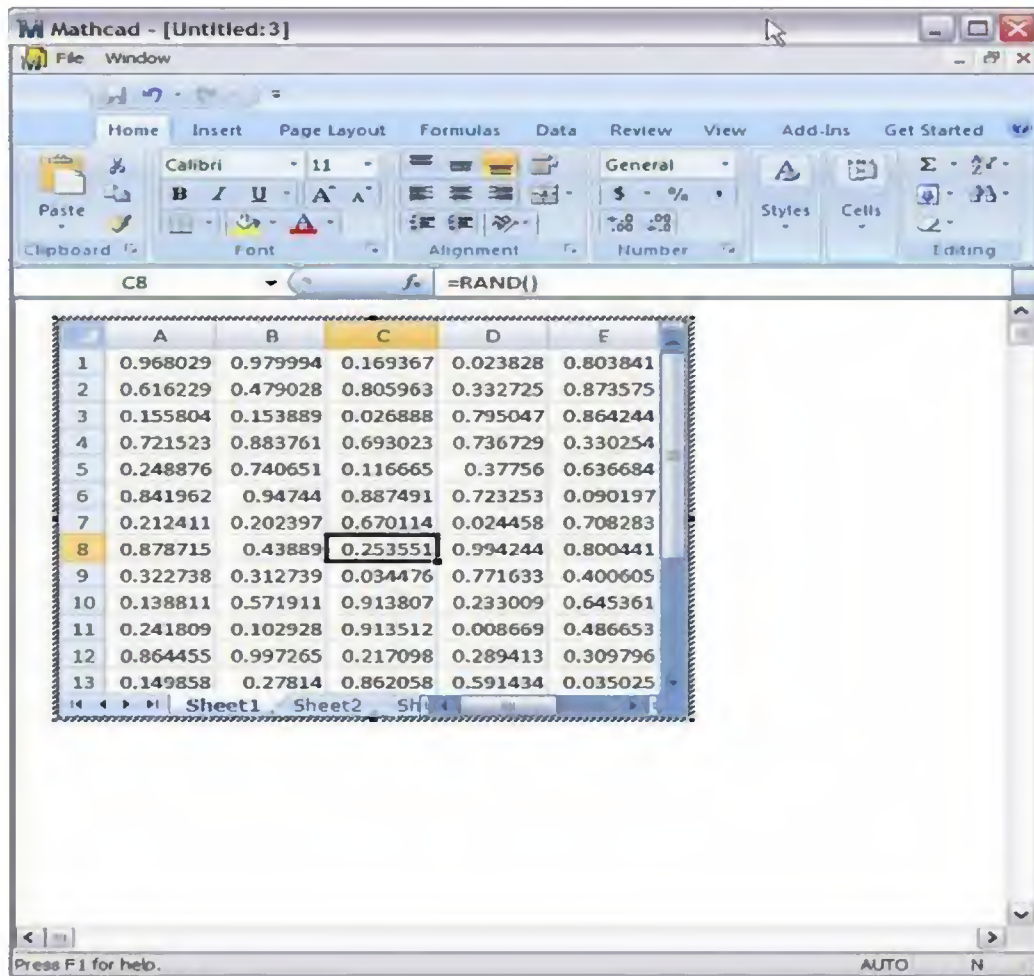
1700 1800 1900 2000

Press F1 for help. AUTO N

Mathcad Unterstützung für die neueste Version von Microsoft Excel®_2

– Nutzen Sie die folgenden Funktionen und Leistungsmerkmale von Excel: READEXCEL(), WRITEEXCEL(), READFILE, den Datenimport-Assistenten und das Excel-Add-In

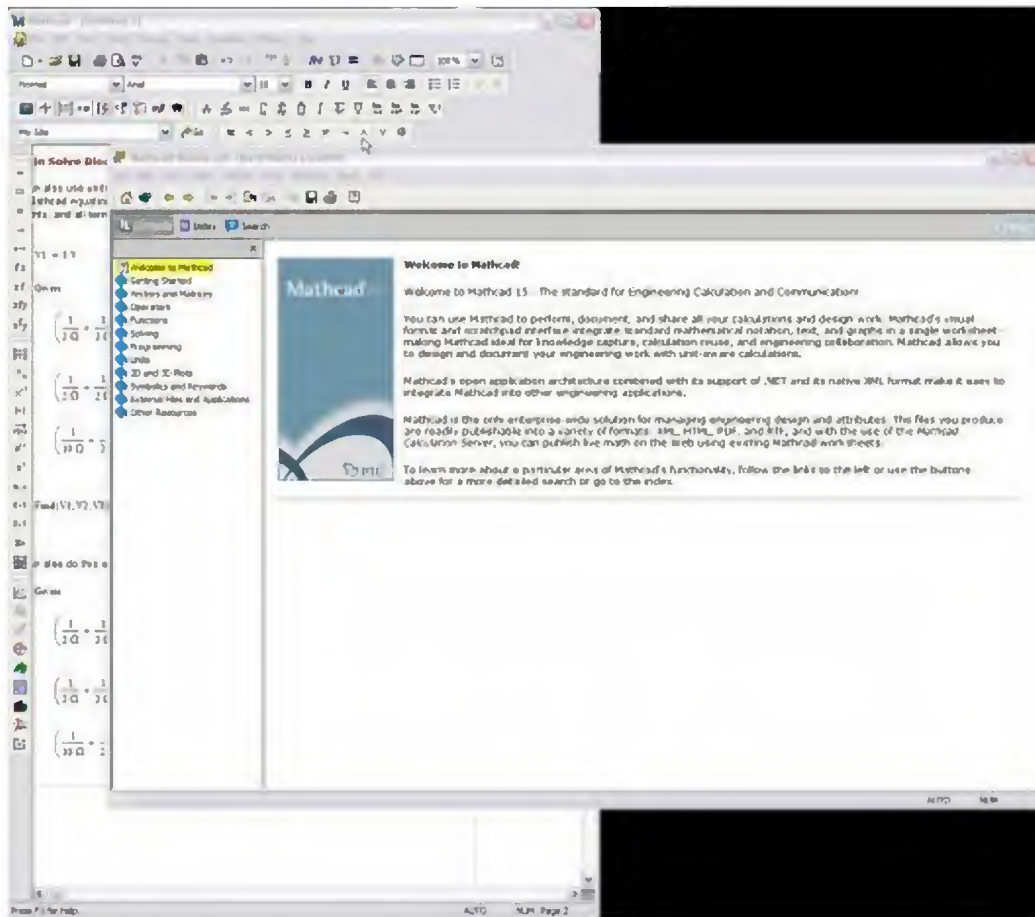
Mathcad 15.0 Unterstützung für die neueste Version von Microsoft Excel®



Unterstützung für die neueste Version von Microsoft Excel®_1

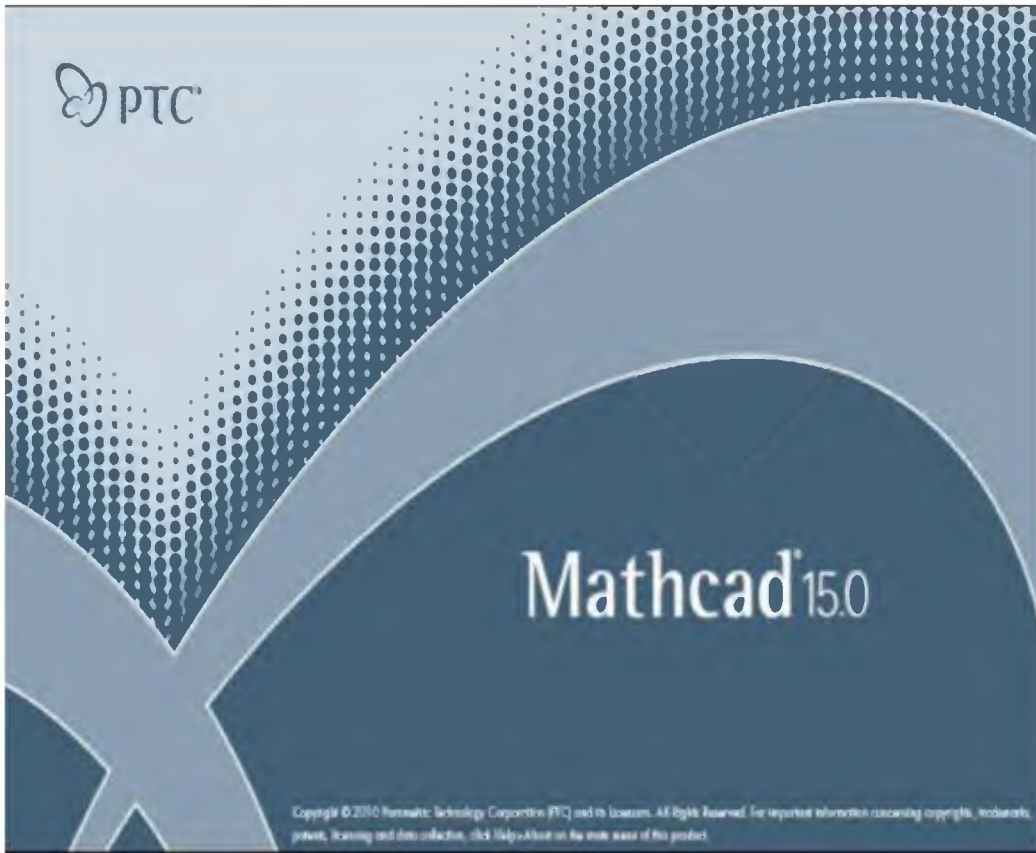
– Nutzen Sie die folgenden Funktionen und Leistungsmerkmale von Excel: READEXCEL(), WRITEEXCEL(), READFILE, den Datenimport-Assistenten und das Excel-Add-In

Mathcad 15.0 (9)



Mathcad 15.0

Mathcad 15.0



Mathcad 15.0

Mathcad 15.0 (8)

Mathcad - [roarks_11_4_11aa_sl_p_5151.xmcd]

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Roark's Formulas for Stress & Strain, Seventh Edition. Copyright © 2002 McGraw-Hill
Chapter 11. Flat Plates
Table 11.4. Formulas for flat plates with straight boundaries and constant thickness.

11. Rectangular plate; two adjacent edges fixed, two remaining edges free.
11aa. Uniform over plate from $x = 0$ to $x = (2/3)b$.

Disclaimer

User Notices

A rectangular flat plate of thickness t , length a and width b is loaded with a uniform load q over plate from $x = 0$ to $x = (2/3)b$ as shown in Figure 1. Determine the bending stress and reaction force per unit length in the plate. Nomenclature is shown in Figure 2.

FIGURE 1

FIGURE 1

Note: Initial values have been assigned to the input variables; redefine these with your values
Note: The analysis below assumes Poisson's ratio to be 0.2

Geometry

Length of the plate:	$a = 250 \text{ mm}$
Width of the plate:	$b = 500 \text{ mm}$
Thickness of the plate:	$t = 7 \text{ mm}$

Material Properties

Modulus of elasticity of plate material:	$E = 200 \text{ GPa}$
--	-----------------------

Loads and Constraints

Uniform load:	$q = 7000 \text{ kPa}$
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Press F1 for help

AUTO NUM Page 1

Integration mit Knowel® Math-Inhalten_5

– Schneller Zugriff auf die Liste aller voll dokumentierten Mathcad Arbeitsblätter aus den Nachschlagewerken von Roark und Hick zur schnelleren Lösung komplexer mathematischer Aufgabenstellungen.

Mathcad 15.0 (7)

Mathcad - [hicks_us_p_5 821.zmcd]

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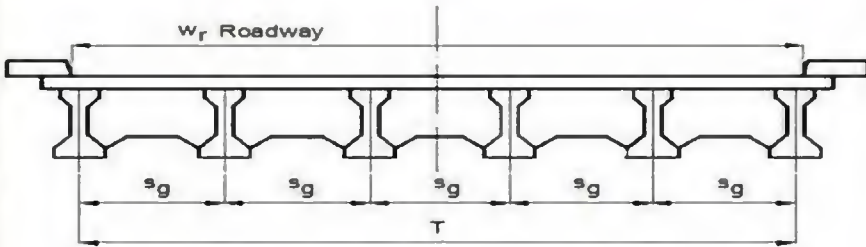
Design of a Prestressed Concrete Bridge

Disclaimer

User Notices

Design a prestressed concrete bridge with a span of L , a roadway width of w_r , a provision for future wearing surface of w_s , and an AASHTO live load—H20-S16-44. The minimum strength of prestressed girders when the prestressing force is transferred from anchorages shall be f_{cr} . Minimum ultimate strength of girders at 28 days shall be f_u . Minimum ultimate strength of the poured-in-place deck slab at 28 days shall be f_d .

Important Notice: The design procedure given here follows the general AASHTO steps. However, the latest editions of AASHTO and Joint ACI-ASCE Recommendations should also be followed in actual design work. Whenever such AASHTO and ACI-ASCE steps are followed in this calculation procedure, this fact will be noted by the expression *design procedure* or *design guide*.



The diagram shows a cross-section of a bridge with a roadway width w_r and a total width T . The bridge consists of n_g girders spaced at s_g intervals. The roadway is supported by a central girder and two side girders.

FIGURE 49

Geometry

Span of the concrete bridge	$L_c = 75 \text{ ft}$
Width of roadway	$w_r = 28 \text{ ft}$
Spacing	$s_g = 5.5 \text{ ft}$
Number of girders	$n_g = 6$
Total width from the figure above:	$L_w = (n_g - 1) s_g$
	$T = 27.500 \text{ ft}$
Top width of girder	$b = 16 \text{ in}$

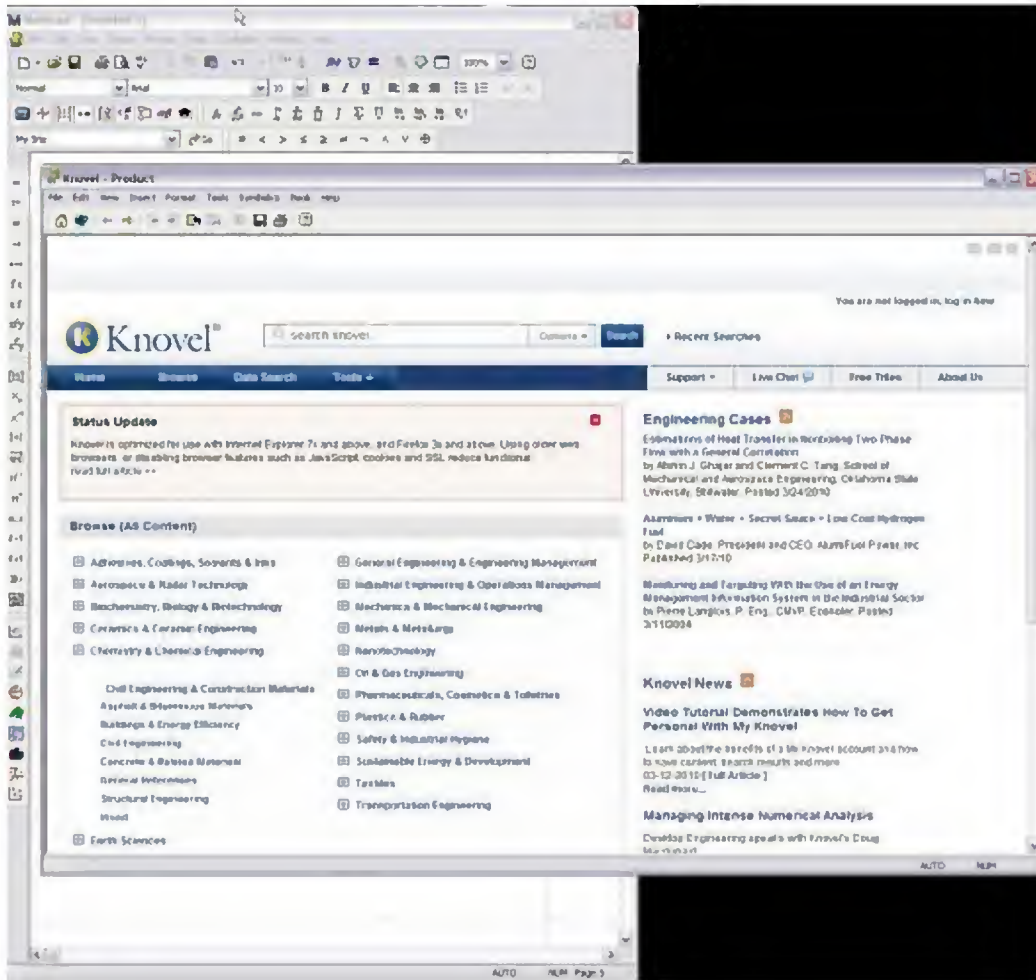
Press F1 for help

AUTO M.M. Page 1

Integration mit Knovel® Math-Inhalten_4

– Schneller Zugriff auf die Liste aller voll dokumentierten Mathcad Arbeitsblätter aus den Nachschlagewerken von Roark und Hick zur schnelleren Lösung komplexer mathematischer Aufgabenstellungen.

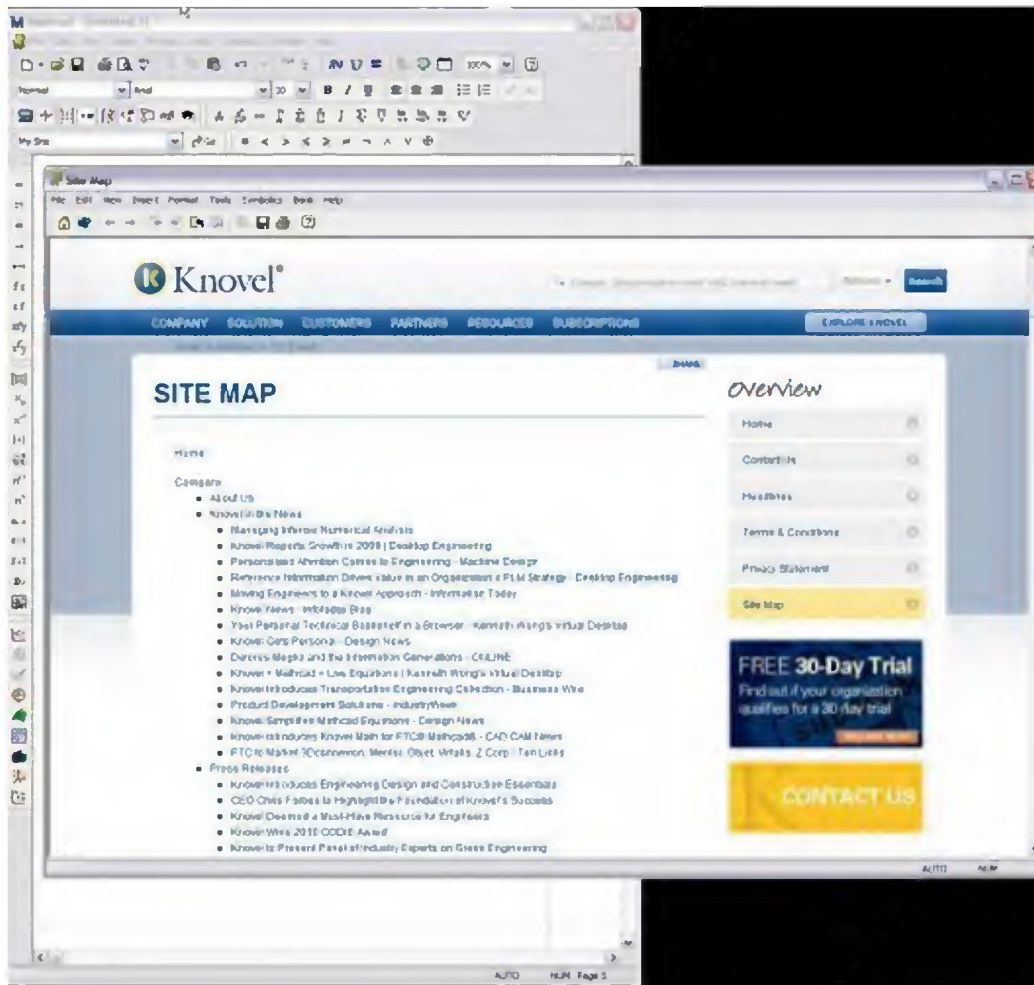
Mathcad 15.0 (6)



Integration mit Knovel® Math-Inhalten_3

– Schneller Zugriff auf die Liste aller voll dokumentierten Mathcad Arbeitsblätter aus den Nachschlagewerken von Roark und Hick zur schnelleren Lösung komplexer mathematischer Aufgabenstellungen.

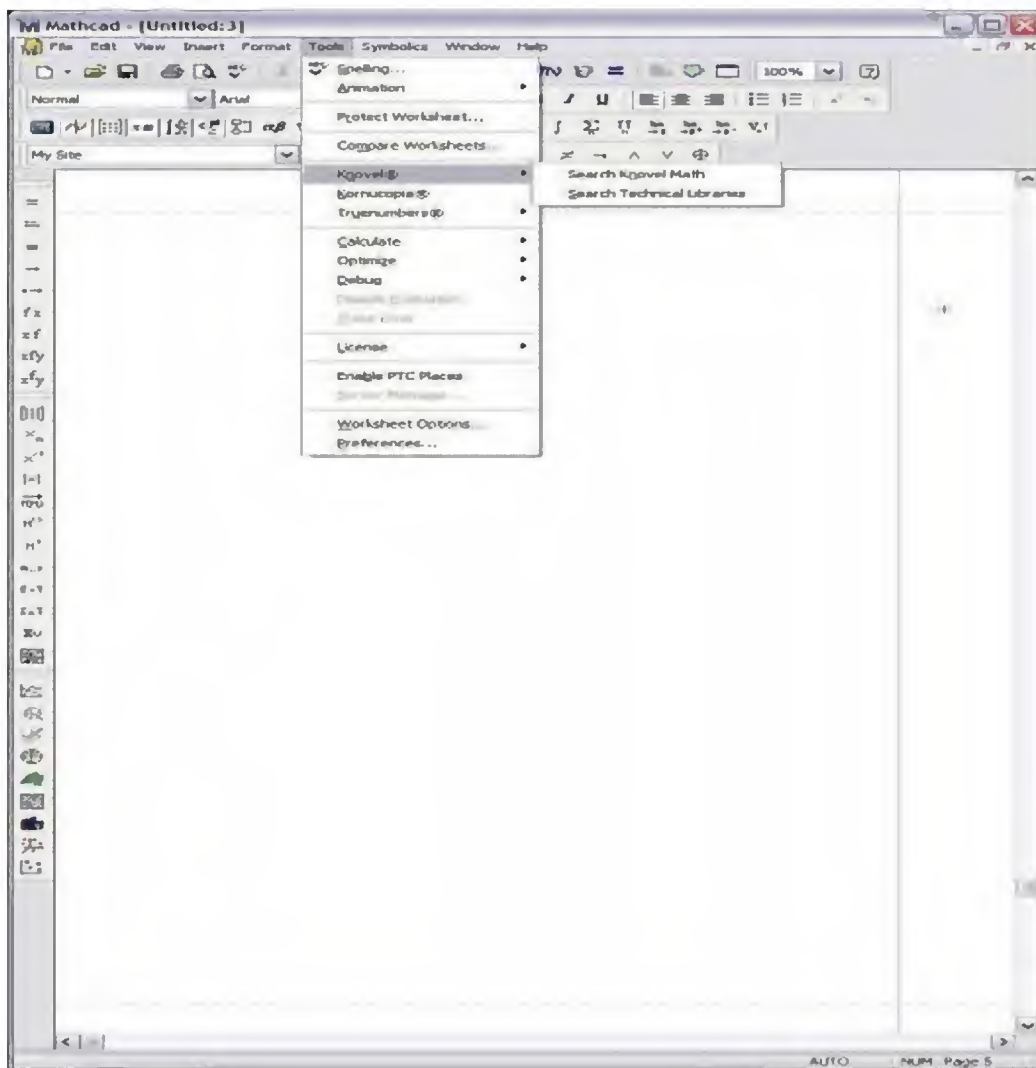
Mathcad 15.0 (5)



Integration mit Knovel® Math-Inhalten_2

– Schneller Zugriff auf die Liste aller voll dokumentierten Mathcad Arbeitsblätter aus den Nachschlagewerken von Roark und Hick zur schnelleren Lösung komplexer mathematischer Aufgabenstellungen.

Mathcad 15.0 (4)



Integration mit Knovel® Math-Inhalten_1

Mathcad 15.0 (3)

5. Form an analysis of variance table to characterize the fit

	Sum of Squares	DF	Mean Square	F Factor
Regression	$SSR = 4.416 \times 10^4$	$df_{param} = 2$	$MSR = 2.208 \times 10^4$	$F_0 = \frac{MSR}{MSE} = 82.505$
Error	$SSE = 3.479 \times 10^3$	$df_{error} = 13$	$MSE = 267.604$	
Total	$SST = 4.764 \times 10^4$	$df_{total} = 15$		

You can compare the table above with the polytstat ANOVA matrix

"Sources"	"SSE"	"DF"	"MSE"	"F"	"P"
"Regression"	4.416×10^4	2	2.208×10^4	82.505	2.994×10^{-9}
"A"	4.064×10^4	1	4.064×10^4	151.872	6.017×10^{-10}
"B"	3.316×10^3	1	3.316×10^3	12.392	1.023×10^{-3}
"Residual"	3.479×10^3	13	267.604	NaN	NaN
"Lack of Fit"	3.479×10^3	13	267.604	NaN	NaN
"Pure Error"	0	0	0	NaN	NaN
"Total"	4.764×10^4	15	NaN	NaN	NaN

6. Estimate of how well the model fits the data

$$R^2 := 1 - \frac{SSE}{SST}$$

$$R^2 = 0.927$$

This indicates that 92.7% of the variability in viscosity is explained by the linear regression model.

7. Define the level of significance for an hypothesis test to test if the model fits the data

$$\alpha = 0.05$$

8. Calculate the critical F-value

$$F_C = qF(1 - \alpha, df_{param}, df_{error}) = 3.806$$

9. Test the hypothesis that the model fits the data

$$F_0 > F_C = 1$$

Accept the hypothesis. You can predict the viscosity of the polymer with this linear regression model.

Mathcad 15.0 DoE (Design of Experiment, Statistische Versuchsplanung)_3

Mathcad 15.0 (2)

Use the **quickscreen** and **effects** functions to calculate the effects of factors, factor levels, blocking, and interactions in design experiments.

1. Call **fullfact** to create a design matrix to test the nickel plating process used to manufacture high-technology disks for computer disk drives. The factor A stands for the process temperature (16°C and 32°C) and factor B stands for the process time (4s and 12s).

$$X = \text{fullfact}(2) = \begin{pmatrix} \text{"Run"} & \text{"Block"} & \text{"A"} & \text{"B"} \\ 1 & 1 & -1 & -1 \\ 2 & 1 & -1 & 1 \\ 3 & 1 & 1 & -1 \\ 4 & 1 & 1 & 1 \end{pmatrix}$$

2. Call **block** to divide the design matrix into two blocks to carry out the experiment in two separate labs.

$$B = \text{block}(X, 2) = \begin{pmatrix} \text{"Run"} & \text{"Block"} & \text{"A"} & \text{"B"} \\ 1 & 1 & -1 & 1 \\ 2 & 1 & 1 & -1 \\ 3 & 2 & -1 & -1 \\ 4 & 2 & 1 & 1 \end{pmatrix}$$

You can also choose a specific factor or interaction to block:

$$\text{block}(X, \text{"B"}) = \begin{pmatrix} \text{"Run"} & \text{"Block"} & \text{"A"} & \text{"B"} \\ 1 & 1 & -1 & -1 \\ 2 & 1 & 1 & -1 \\ 3 & 2 & -1 & 1 \\ 4 & 2 & 1 & 1 \end{pmatrix}$$

3. Record the thickness readings in matrix Y with one row per run and one column per replicate.

$$Y = \begin{pmatrix} 116.1 & 116.9 & 112.6 & 118.7 & 114.9 \\ 116.5 & 115.5 & 119.2 & 114.7 & 118.3 \\ 106.7 & 107.5 & 105.9 & 107.1 & 106.5 \\ 123.2 & 125.1 & 124.5 & 124.0 & 124.7 \end{pmatrix}$$

For later reference, define r1, r2, r3, and r3 to be the average thickness

Mathcad 15.0 DoE (Design of Experiment, Statistische Versuchsplanung)_2

Mathcad 15.0 (1)

12 Create a box plot.

a. Plot the output of the `boxplotgraph` function:

b. Create text regions with the labels for each factor:

When looking at the box plot, it seems that the cotton weight percentage influences the tensile strength of the fiber. The tensile strength of the fiber reaches a maximum when the cotton weight is about 30% of the fiber weight.

13. Call the `anova` function to test if the cotton weight percentage influences the tensile strength.

```

 $\Delta = \text{anova}(X, Y)$ 

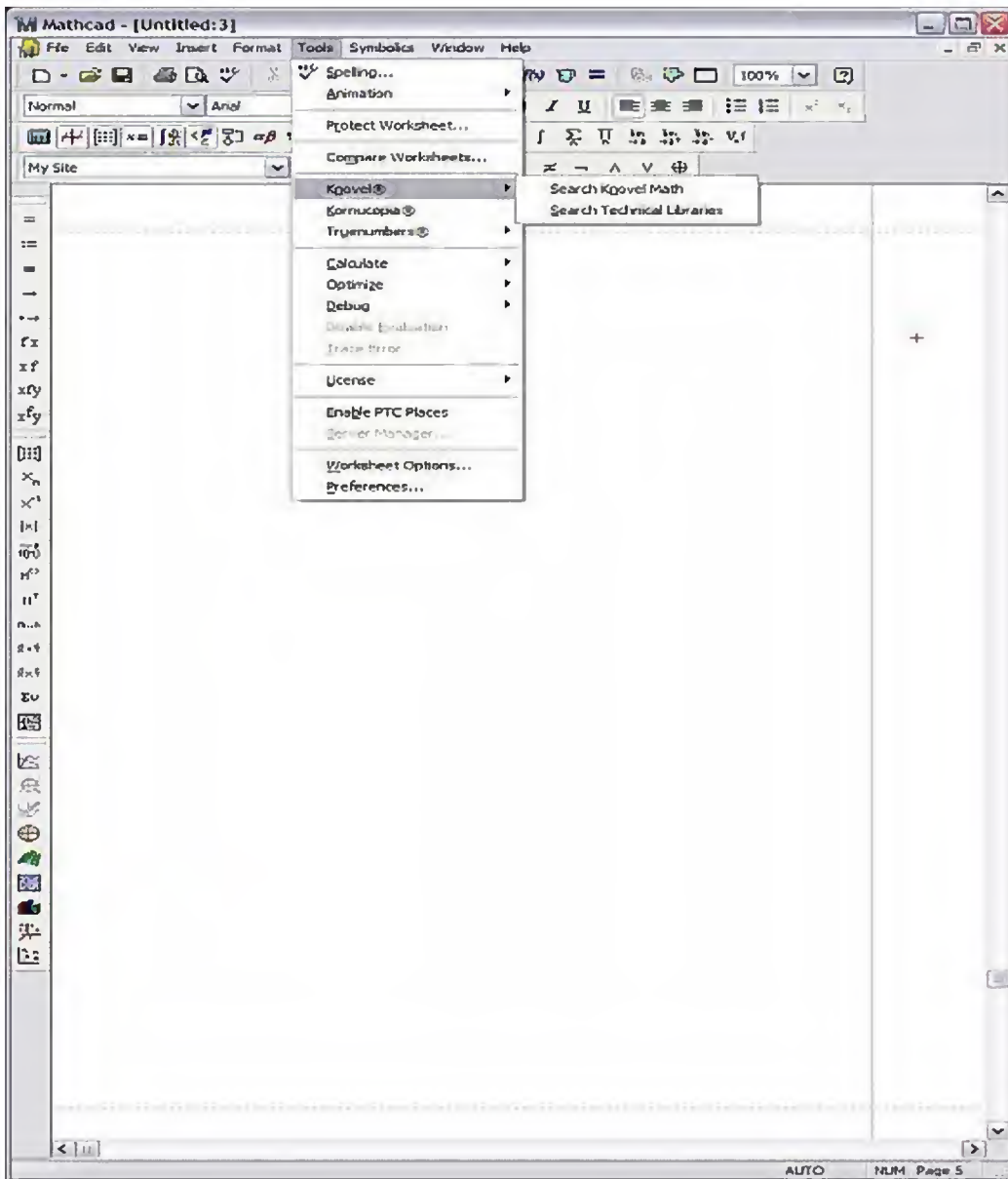
```

"Source"	"SSE"	"DF"	"MSE"	"F"	"P"
"A"	473.76	4	118.04	14.737	$4.482 \cdot 10^{-6}$

Press F1 for help. AUTO NLM Page 1

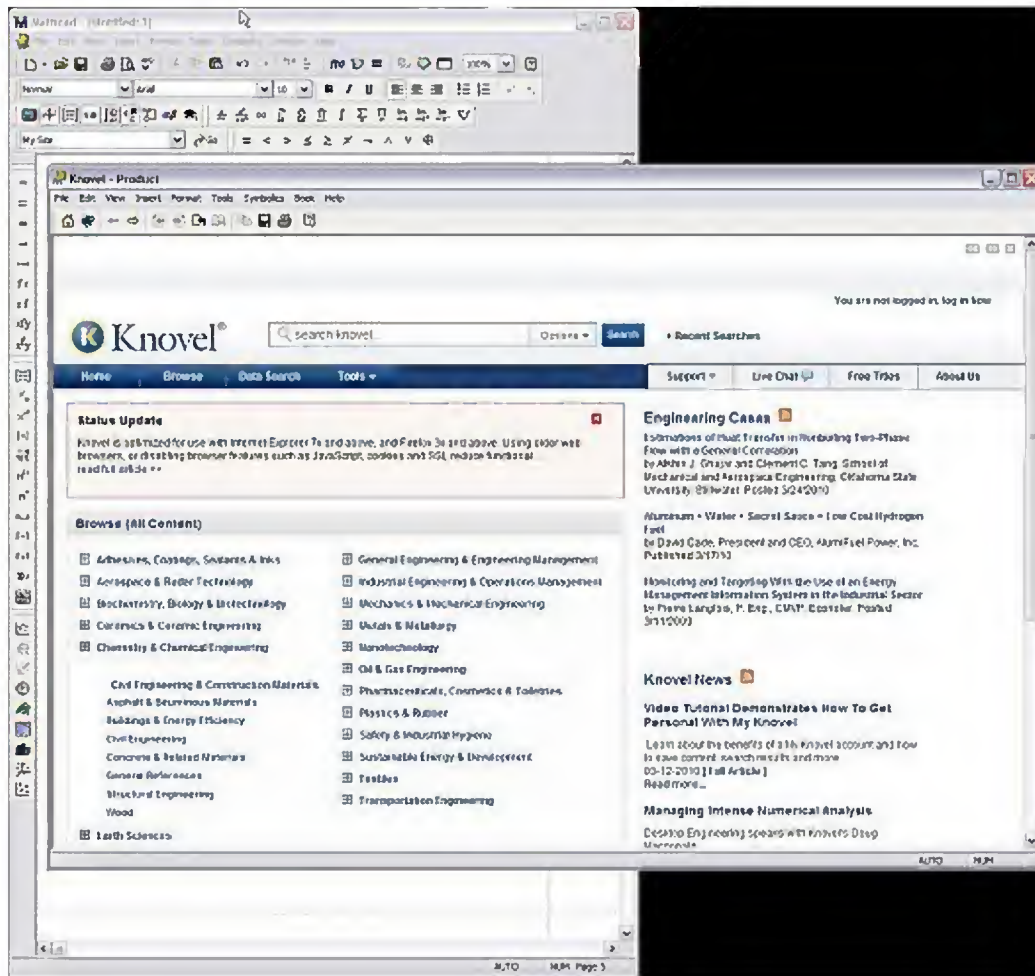
Mathcad 15.0 DoE (Design of Experiment, Statistische Versuchsplanung)_1

Knovel Math-Inhalt



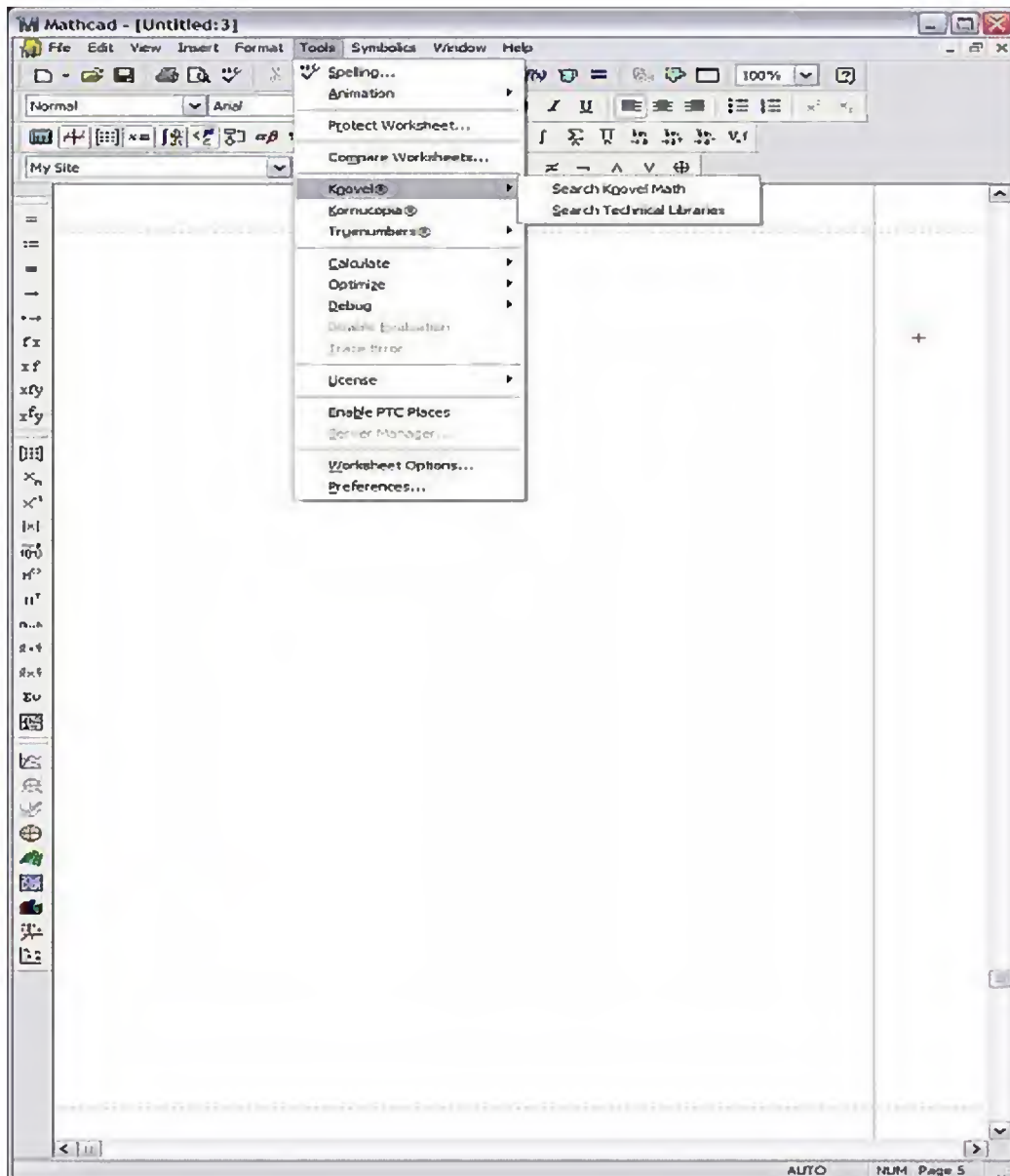
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Roark's Formulas for Stress & Strain, Seventh Edition, Copyright © 2002 McGraw-Hill
Chapter 11 Flat Plates
Table 11.4. Formulas for flat plates with straight boundaries and constant thickness.

11. Rectangular plate; two adjacent edges fixed, two remaining edges free.
11aa. Uniform over plate from $z = 0$ to $z = (2/3)b$.

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A rectangular flat plate of thickness t , length a and width b is loaded with a uniform load q over plate from $z = 0$ to $z = (2/3)b$ as shown in Figure 1. Determine the bending stress and reaction force per unit length in the plate. Nomenclature is shown in Figure 2.

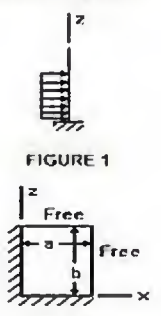


FIGURE 1

FIGURE 1

Note: Initial values have been assigned to the input variables; redefine these with your values.
Note: The analysis below assumes Poisson's ratio to be 0.2.

Geometry

Length of the plate: $a := 250\text{-mm}$
Width of the plate: $b := 500\text{-mm}$
Thickness of the plate: $t := 7\text{-mm}$

Material Properties

Modulus of elasticity of plate material: $E := 200\text{-GPa}$

Loads and Constraints

Uniform load: $q := 7000\text{-kPa}$

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Knovel Math-Inhalt

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Mathcad - [hicks_us_p_5 821.xmcd]

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Design of a Prestressed Concrete Bridge

Disclaimer

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Design a prestressed concrete bridge with a span of L , a roadway width of w_r , a provision for future wearing surface of w_s , and an AASHTO live load—H20-S16-44. The minimum strength of prestressed girders when the prestressing force is transferred from anchorages shall be f_{oi} . Minimum ultimate strength of girders at 28 days shall be f_g . Minimum ultimate strength of the poured-in-place deck slab at 28 days shall be f_d .

Important Notice: The design procedure given here follows the general AASHTO steps. However, the latest editions of AASHTO and Joint ACI-ASCE Recommendations should also be followed in actual design work. Whenever such AASHTO and ACI-ASCE steps are followed in this calculation procedure, this fact will be noted by the expression *design procedure or design guide*.

The diagram shows a cross-section of a bridge with six girders. The roadway width is labeled w_r . The spacing between girders is labeled s_g . The total width of the bridge is labeled T . A vertical dashed line indicates the centerline.

FIGURE 49

Geometry

Span of the concrete bridge: $L := 75 \text{ ft}$

Width of roadway: $w_r := 28 \text{ ft}$

Spacing: $s_g := 5.5 \text{ ft}$

Number of girders: $n_g := 6$

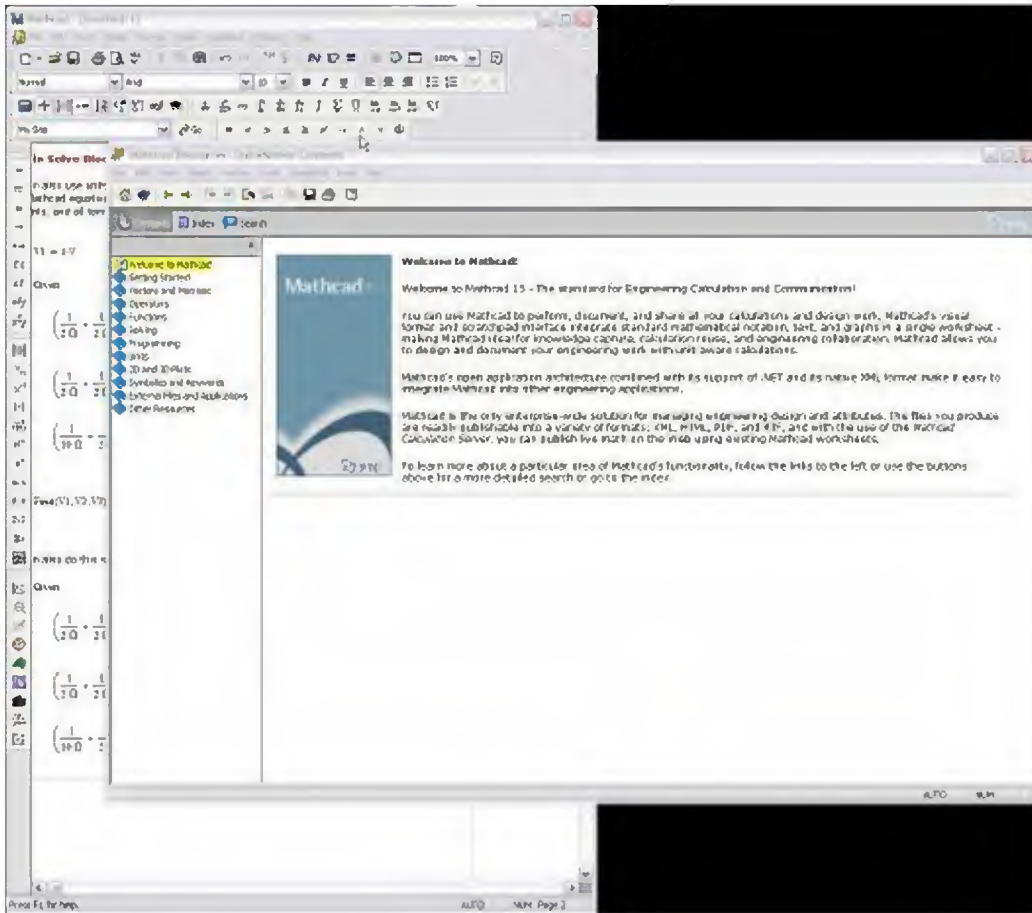
Total width from the figure above: $T_w := (n_g - 1) \cdot s_g$
 $T = 27.500 \text{ ft}$

Top width of girder: $b := 16 \text{ in}$

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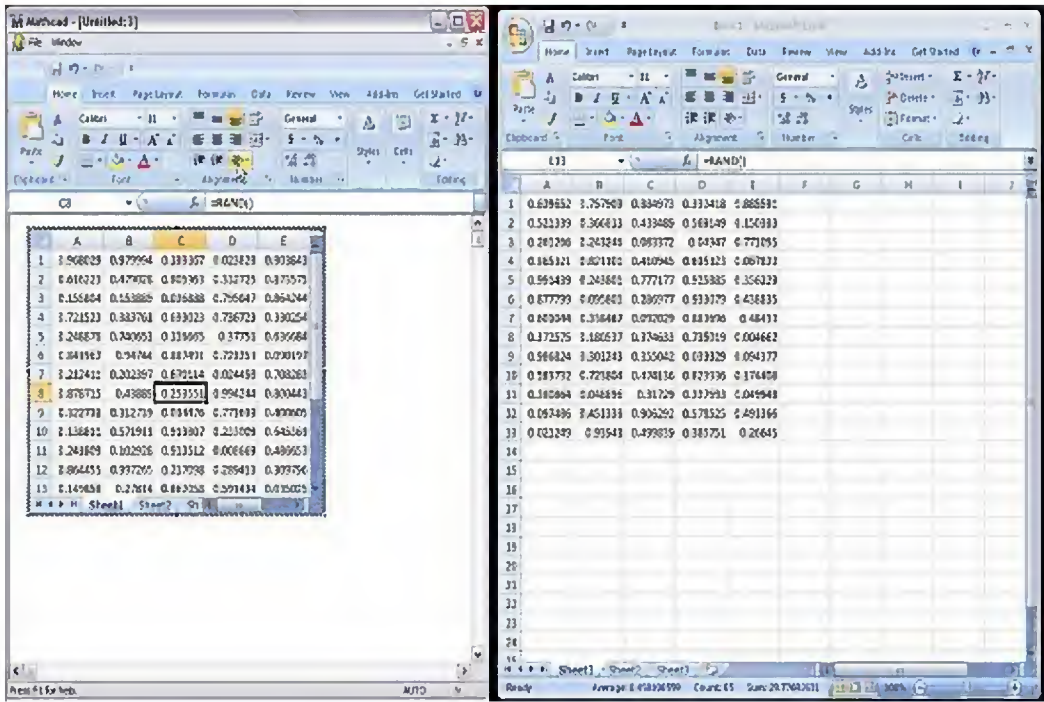
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Mathcad 15.0



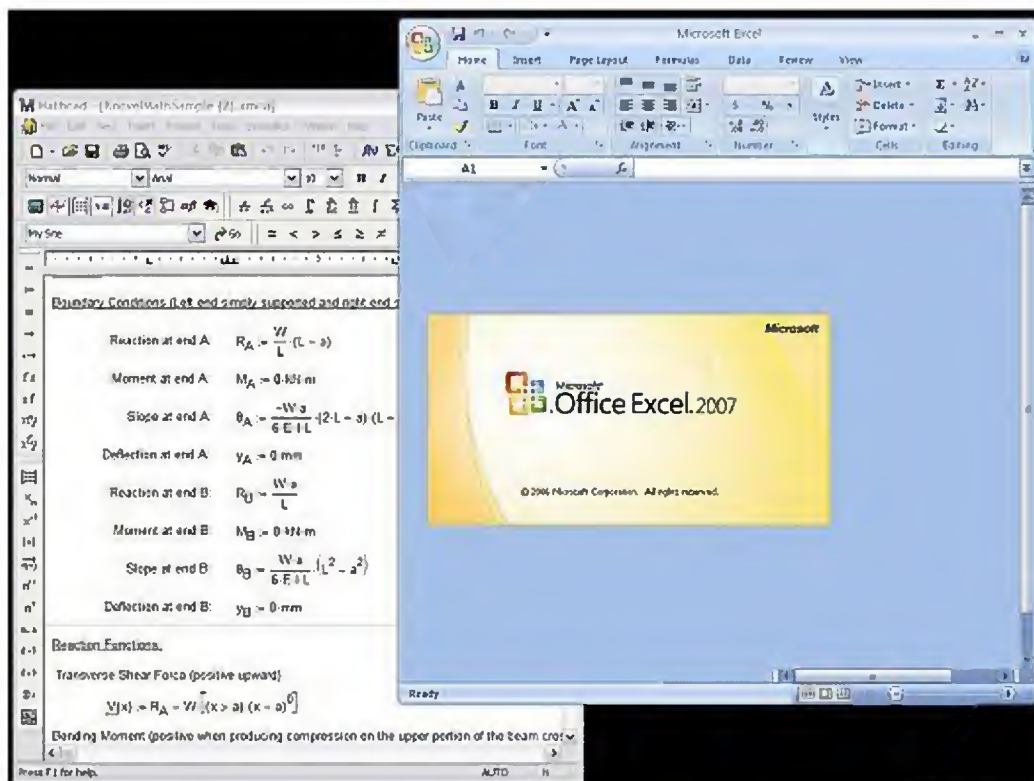
Mathcad 15.0

Microsoft Excel 2007-Unterstützung



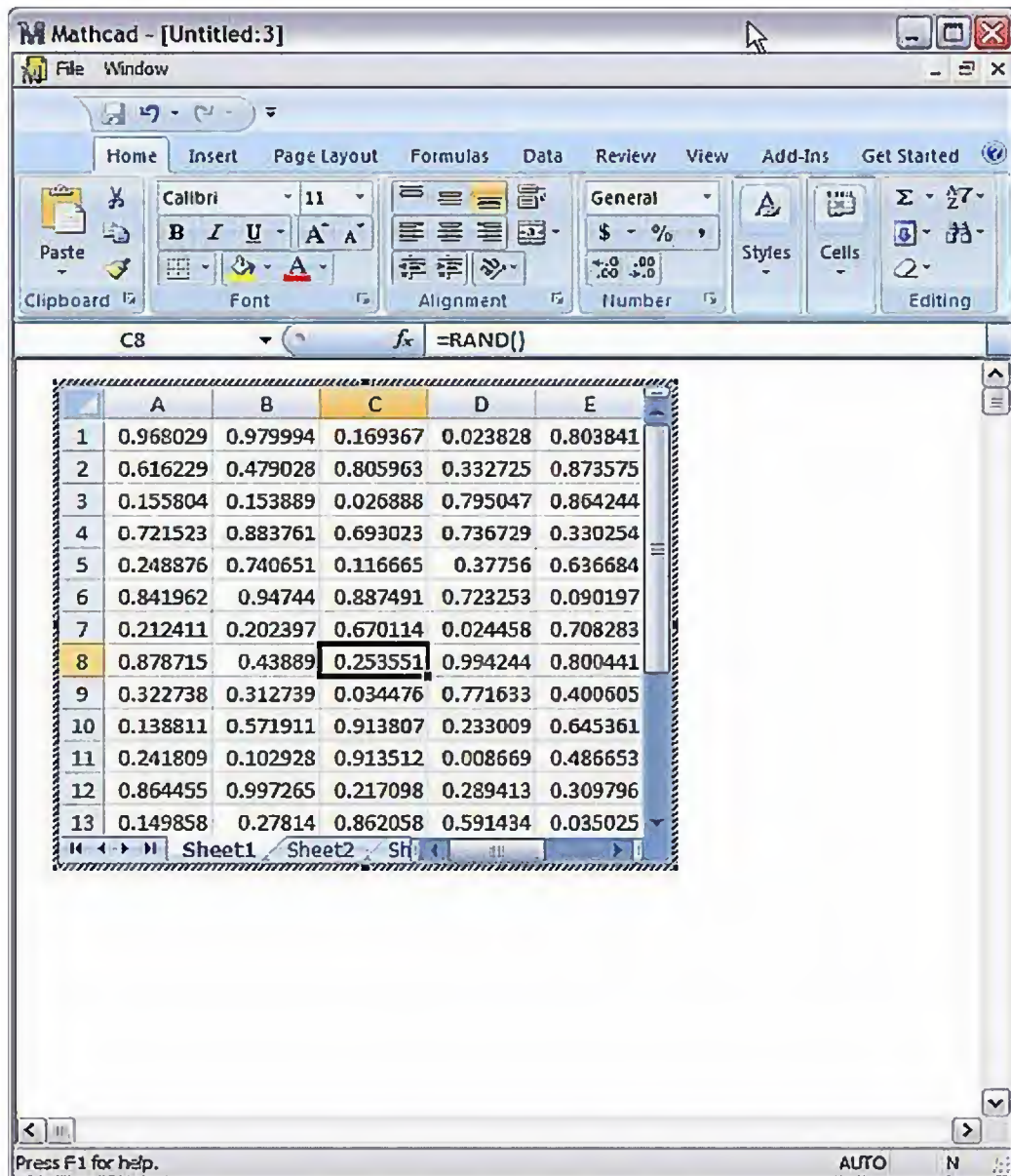
Microsoft Excel 2007-Unterstützung

Microsoft Excel 2007-Unterstützung



Microsoft Excel 2007-Unterstützung

Microsoft Excel 2007-Unterstützung



Microsoft Excel 2007-Unterstützung

Microsoft Excel 2007-Unterstützung

The screenshot shows the Mathcad interface with an embedded Excel spreadsheet. The spreadsheet contains the following data:

years	A	B
10	1706	29
11	1707	20
12	1708	10
13	1709	8
14	1710	3
15	1711	0
16	1712	0
17	1713	2
18	1714	11
19	1715	27

Below the spreadsheet is a line graph titled "Annual Sunspot Count". The y-axis is labeled "counts" and ranges from 0 to 200. The x-axis shows years from 1700 to 2000. The graph displays a clear cyclical pattern of sunspot activity.

Text in the Mathcad window:

In 1848 Rudolph Wolf devised a daily method of estimating solar activity by counting the number of individual spots and groups of spots on the face of the sun. The Excel spreadsheet shown contains annual totals of sunspots from 1700 to 1995.

Tip: Double-click on the Excel component to activate it in-place. Activating the component opens the Excel environment to allow you to edit the data.

Tip: To change the component's properties, right-click on it then choose Properties from the menu.

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Microsoft Excel 2007-Unterstützung

Statistische Versuchsplanung (Design of Experiments, DOE)

Use the quickscreen and effects functions to calculate the effects of factors, factor levels, blocking, and interactions in design experiments.

- Call `fullfact` to create a design matrix to test the nickel plating process used to manufacture high-technology disks for computer disk drives. The factor A stands for the process temperature (15°C and 32°C) and factor B stands for the process time (4s and 12s).

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- Call `block` to divide the design matrix into two blocks to carry out the experiment in two separate labs.

$$B := \text{block}(X, 2) = \begin{pmatrix} \text{"Run"} & \text{"Block"} & \text{"A"} & \text{"B"} \\ 1 & 1 & -1 & 1 \\ 2 & 1 & 1 & -1 \\ 3 & 2 & -1 & -1 \\ 4 & 2 & 1 & 1 \end{pmatrix}$$

You can also choose a specific factor or interaction to block:

$$\text{block}(X, \text{"B"}) = \begin{pmatrix} \text{"Run"} & \text{"Block"} & \text{"A"} & \text{"B"} \\ 1 & 1 & -1 & -1 \\ 2 & 1 & 1 & -1 \\ 3 & 2 & -1 & 1 \\ 4 & 2 & 1 & 1 \end{pmatrix}$$

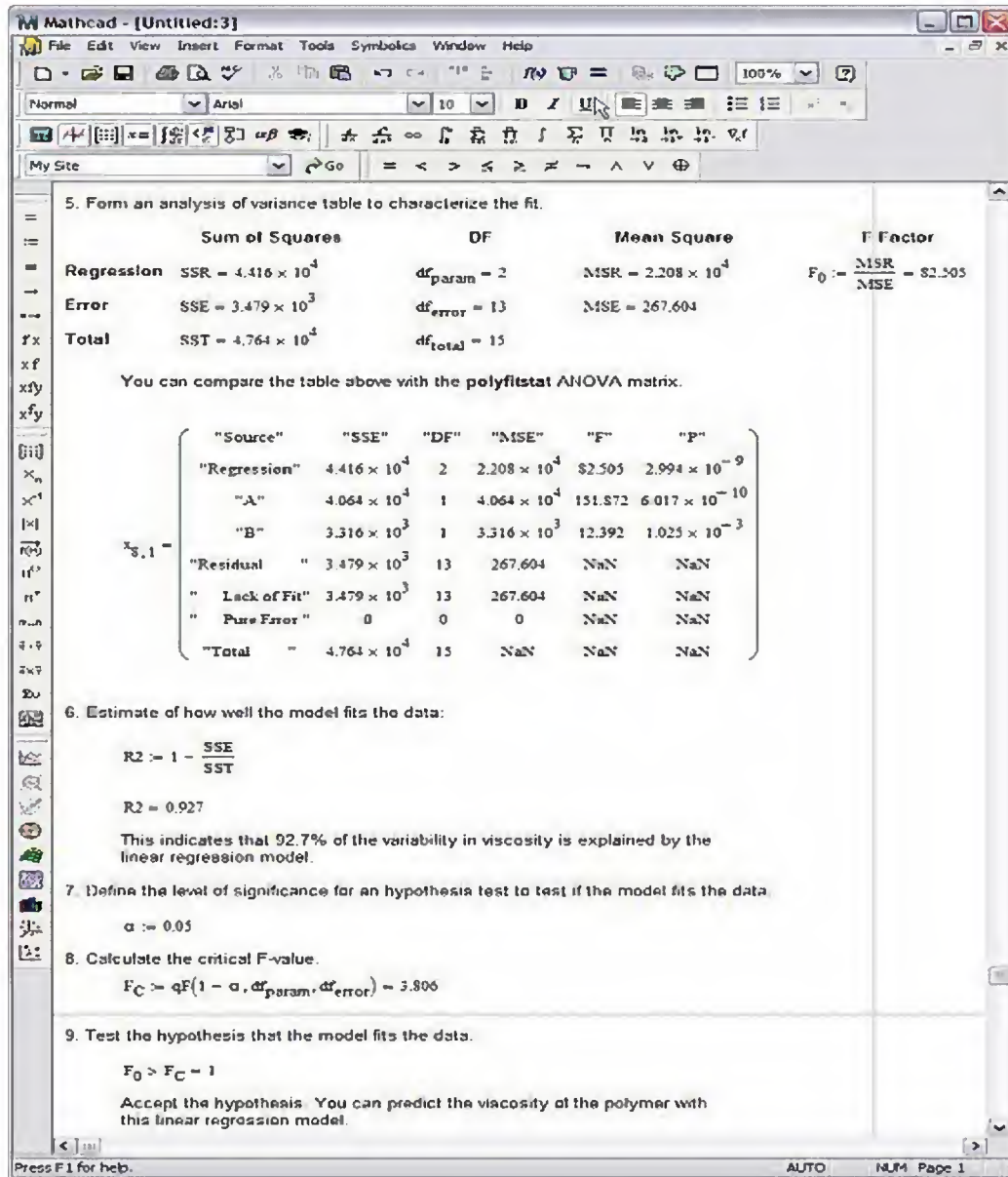
- Record the thickness readings in matrix Y with one row per run and one column per replicate.

$$Y := \begin{pmatrix} 116.1 & 116.9 & 112.6 & 118.7 & 114.9 \\ 116.5 & 115.5 & 119.2 & 114.7 & 118.3 \\ 106.7 & 107.3 & 105.9 & 107.1 & 106.5 \\ 123.2 & 125.1 & 124.5 & 124.0 & 124.7 \end{pmatrix}$$

For later reference, define `r1`, `r2`, `r3`, and `r3` to be the average thickness readings for each ...

Statistische Versuchsplanung (Design of Experiments, DOE)

Statistische Versuchsplanung (Design of Experiments, DOE)



Statistische Versuchsplanung (Design of Experiments, DOE)

Statistische Versuchsplanung (Design of Experiments, DOE)

12. Create a box plot

a. Plot the output of the boxplotgraph function:

b. Create text regions with the labels for each factor:

When looking at the box plot, it seems that the cotton weight percentage influences the tensile strength of the fiber. The tensile strength of the fiber reaches a maximum when the cotton weight is about 30% of the fiber weight.

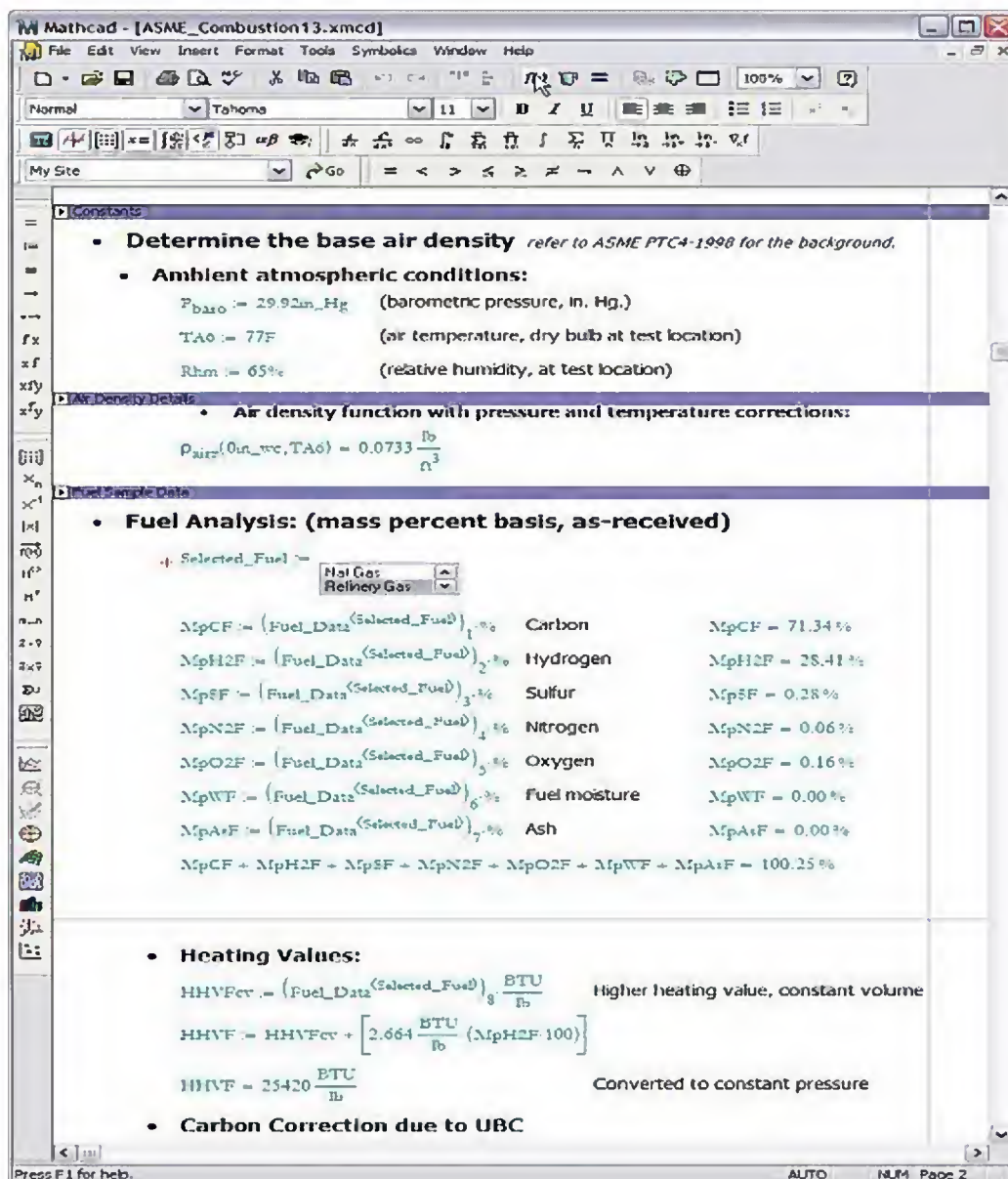
13. Call the `anova` function to test if the cotton weight percentage influences the tensile strength

`A:= anova(X, Y)`

Source	SSE	DF	MSE	F	P
A	475.76	4	118.94	14.757	3.482 × 10 ⁻⁶

Statistische Versuchsplanung (Design of Experiments, DOE)

Truenumbers-Integration



Truenumbers-Integration

Truenumbers-Integration

Mathcad - [ASME_Combustion13.xmcd]

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Normal Tahoma 11

My Site

non-Excess Air based calcs

- Create an Excess Air Function: (para. 5.11.4.1 and 5.11.4.3)

$$\text{ExcessAir}(O_2, \text{WetDry}) := \begin{cases} \frac{O_2 \cdot (\Delta MoDPe - 0.7905 \cdot \Delta MoThACr)}{\Delta MoThACr [20.95\% - O_2]} & \text{if WetDry} = \text{Dry} \\ \frac{O_2 [\Delta MoWPe + \Delta MoThACr (0.7905 + \Delta MoWA)]}{\Delta MoThACr [20.95\% - O_2 (1 + \Delta MoWA)]} & \text{otherwise} \end{cases}$$

- Graph the Excess O₂ vs Excess Air Curve:

Excess Air Graph Setup data

Excess Air Chart

Excess Air, %

Excess Oxygen, % volume

— Excess Air for Dry O₂
— Excess Air for Wet O₂

- EPA F factors
- Select a fuel type

Type := Calc
Anhydrous
Gas
Liquid

For Help, press F1

AUTO NUM Page 5

Truenumbers-Integration

Truenumbers-Integration

Flue Gas Analysis:

- Steam generator outlet (ASME 14):**
 - $O_2 := 3.20\%$ Excess oxygen measured at the steam generator outlet
 - $CO := 80\text{ppm}$ CO measured at the steam generator outlet
 - $NO_x := 333\text{ppm}$ NOx at the steam generator outlet
 - $P_{fg} := -2.0\text{in}_{wg}$ static pressure (draft)
 - $T_{fg} := 620F$ gas temperature
- Select the measurement basis for the gas samples:
 - Excess Air $O_2\text{Basis} :=$
 - Flue gas emissions: *NOTE: only emissions on the same basis (wet or dry) are handled by this form*
 - Emission Basis := Emission Ref :=
- Excess air at the steam generator outlet:
 - $XpA_{14} := \text{ExcessAir}(O_2, O_2\text{Basis})$ $XpA_{14} = 20.53\%$

Air Based Combustion Coeffs:

- Air weight: $M_{qA} = 862.61 \frac{\text{lb}}{\text{MBTU}}$
- Flue gas weight: $M_{qFg} = 901.95 \frac{\text{lb}}{\text{MBTU}}$
- Flue gas moisture: $M_{pWFg} = 12.20\%$
- Molecular weight of flue gas: $M_{wFg} = 27.51 \frac{\text{lb}}{\text{mol}}$
- Flue gas density: $\rho_{Fg} = 0.0347 \frac{\text{lb}}{\text{ft}^3}$

CPA NOx Calc:

- NOx emissions rate: $E_{NO_x} = 0.40 \frac{\text{lb}}{\text{MBTU}}$
- CO emissions rate: $E_{CO} = 0.07 \frac{\text{lb}}{\text{MBTU}}$

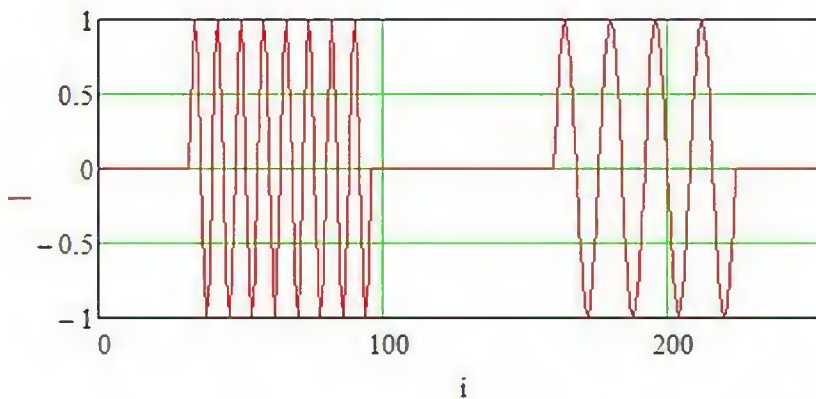
Truenumbers-Integration

Time-frequency analysis

The test signal $x(i)$ is composed of the sum of two tones, with one that is twice the frequency of the other. The two tones are separated in time and frequency so the resulting time-frequency plots should have two distinct peaks.

$$N := 256 \quad i := 0..N - 1$$

$$x(i) := \text{if} \left(\frac{1 \cdot N}{8} \leq i < \frac{3 \cdot N}{8}, \sin \left(2 \cdot \pi \cdot 32 \cdot \frac{i}{N} \right), \left(\text{if} \left(\frac{5 \cdot N}{8} \leq i < \frac{7 \cdot N}{8}, \sin \left(2 \cdot \pi \cdot 16 \cdot \frac{i}{N} \right), 0 \right) \right) \right)$$



create Wavelet Transform Analysis

I can analyze the two-tone signal with the discrete wavelet transform (DWT), the wavelet packet transform (WPT), and the local cosine transform (LCT). Remember that the DWT uses a fixed basis, which is illustrated here using the `wavebs` function. The WPT and LCT can have customized bases. Begin with the DWT:

$$\text{filter} := \text{daublet}(4)$$

Time-frequency analysis

Fingerprint identification applications



F

The Proposed FBI Standard

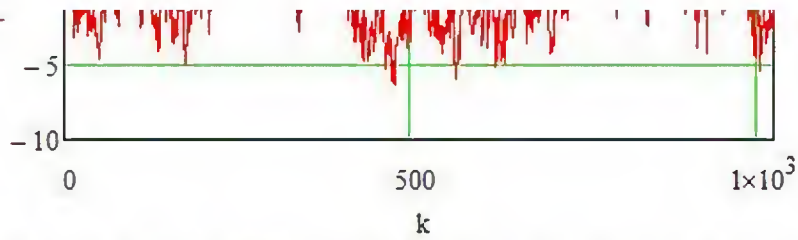
The proposed FBI standard is based on a specific wavelet packet transform with 64 subbands, using a symmlet(8) wavelet. The FBI basis is included below:

T :=

0	0	0	0	0	0	5
0	0	0	0	0	0	5
0	0	0	0	0	0	5
0	0	0	0	0	0	5
0	0	0	0	0	0	4
0	0	0	0	0	0	4
0	0	0	0	0	0	4
0	0	0	0	0	0	4
0	0	0	0	0	0	4
0	0	0	0	0	0	4
0	0	0	0	0	0	4

Fingerprint identification applications

Calculate fractional Brownian motion



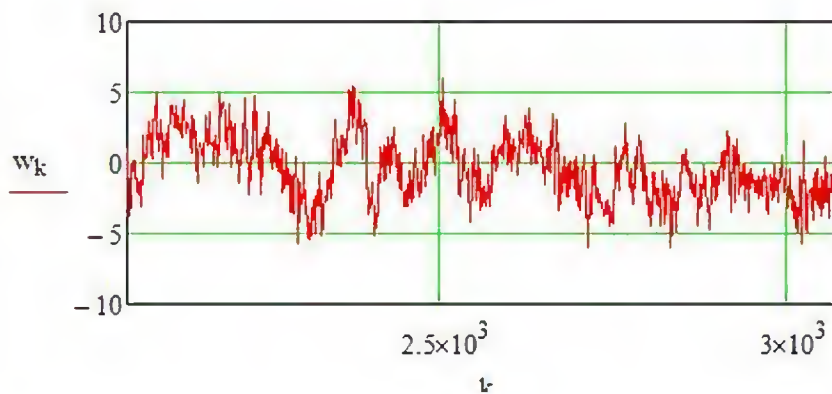
Due to the periodic nature of the wavelet transform, the above result is not a very good approximation to fBm. For example, the end points of the series are quite close to each other, which is not usually the case for correctly simulated fBm series. To obtain a better approximation, you can generate a series of length 4·len and then subsample any len consecutive values.

```
noise := mnorm(len·4, 0, 1) v := fBmScale(noise, H, sd) start := 2
```

```
mn := start·len mx := (start + 1)·len - 1
```

```
k := mn .. mx
```

```
w := idwt(v, log(rows(noise), 2), filter)
```

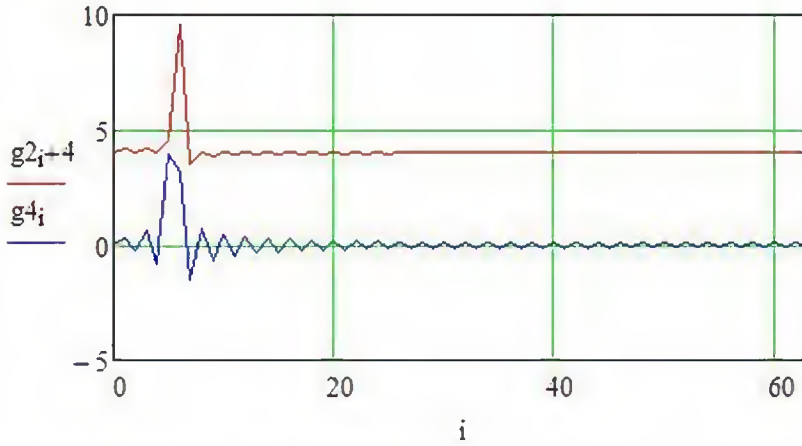


Calculate fractional Brownian motion

Discrete cosine transform equations

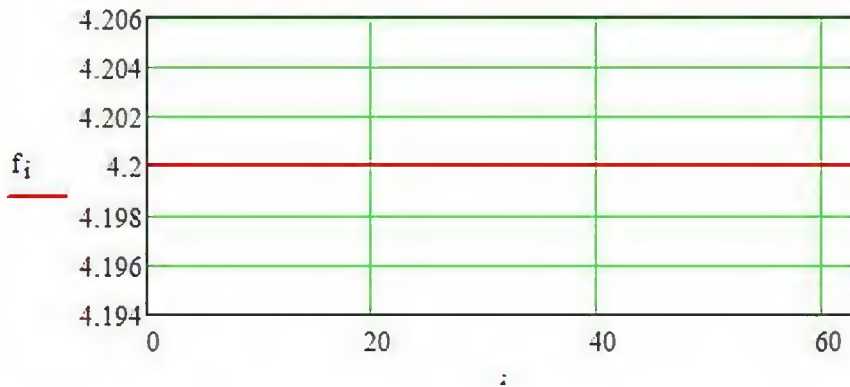
i

Here are the DCT-II and DCT-IV transforms of the signal.



Next, look at a constant valued signal.

$$f_i := 4.2$$



Discrete cosine transform equations

Discrete wavelet transform calculations

compute the forward and inverse wavelet transforms with periodic boundary conditions. These boundary conditions do not have parity restrictions on the data **a**. However, the wavelet transform requires the use of a wavelet that is itself symmetric. This restricts the choice of wavelets that you can use with the **dwts** to the biorthogonal spline wavelets **Bspline(m,n)**, the Daubechies wavelets **db(n)**, and the Haar wavelet **daublet(2)**.

For periodic boundary conditions there are still conditions on the data. It is required that $\text{length}(\mathbf{a}) \geq 2^n$. The maximum level can be determined using the following function:

$$\text{level}(\mathbf{x}) := (\text{cols}(\mathbf{x}) = 1) \cdot \text{floor}\left(\frac{\log(\text{rows}(\mathbf{x}))}{\log(2)}\right) + (\text{cols}(\mathbf{x}) > 1) \cdot \min\left(\text{floor}\left(\frac{\log(\text{rows}(\mathbf{x}))}{\log(2)}\right), \text{floor}\left(\frac{\log(\text{cols}(\mathbf{x}))}{\log(2)}\right)\right)$$

For odd length data, you can directly take a wavelet transform of odd length data:

<p>12 $q_i := \text{rnd}(1)$</p> <p>$\text{dwts}(q, 2, \text{Bspline}(3, 3))$</p> <p>$\text{dwts}(r, 2, \text{Bspline}(3, 3))$</p> <p>$\left. \begin{array}{l} \longrightarrow \\ - q \end{array} \right = 0$</p>	<p>An odd length random vector can be used with the symmetric boundary conditions.</p> <p>The symmetric wavelet transform also gives theoretically perfect reconstruction.</p>
--	--

Discrete wavelet transform calculations

Time-frequency representations

`timefreq(x, "t", f, s, [d])` `timecorr(x, "t", f, s, [d])`
`timefreq(x, ["custom"], s, r)` `timecorr(x, ["custom"], s, r)`

Compute the common bilinear time-frequency representations (BTFRs) and the time-dependent autocorrelation of a signal.

- **x**, real-valued data vector
- **t**, string containing the name of the desired representation (optional for the custom type).
- **f**, integer number of lags (for `timecorr`) or number of frequencies (for `timefreq`) to be computed.
- **s**, step size; an integer giving the number of samples to skip between successive computations.
- **d**, (optional), positive damping factor for the Choi-Williams distribution (defaults to 1). Ignored for other representations
- **r**, a matrix of real numbers giving the time-lag kernel in the case of a custom representation. Required for the "custom" representation.

<i>string t</i>	<i>Representation</i>
wigner	Wigner
cone	cone
bornjordan	Born-Jordan
marghill	Margenau-Hill
choiwill	Choi-Williams
"custom"	custom kernel in the time-lag plane.

Return a matrix with **f** rows and approximately $\text{length}(x)/s$ columns, containing the time-frequency representation or the time-dependent autocorrelation matrix for signal **x**.

Time-frequency representations

Hartley transform function

avoid entering the complex domain. In order to accomplish the latter goal, the Hartley transform restricts its attention to real input data.

Notes

The defining sum for the Hartley transform is analogous to the discrete Fourier transform sum. It is

$$\text{dht}(x)_n = \frac{1}{N} \left[\sum_{k=0..N-1} \left[x_k \cdot \left(\cos\left(\frac{2 \cdot \pi \cdot n \cdot k}{N}\right) + \sin\left(\frac{2 \cdot \pi \cdot n \cdot k}{N}\right) \right) \right] \right]$$

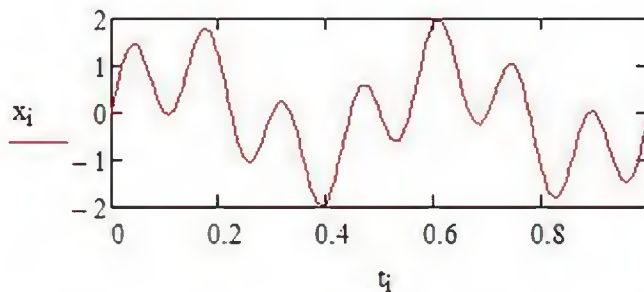
where N is the number of elements in the real data array x .

Example

The Hartley transform for a sum of sine waves is compared with the magnitude of the complex Fourier transform.

$$N := 201 \quad i := 0..N-1$$

$$t_i := \frac{i}{N-1} \quad x_i := \sin(14 \cdot \pi \cdot t_i) + \sin(4 \cdot \pi \cdot t_i)$$



Hartley transform function

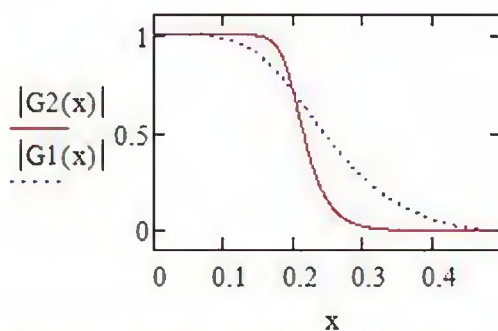
Filter gain analysis

$C := \text{matrix}(\text{columns}(C), x)$

$$C = \begin{pmatrix} 0.277 & 1 & 0.207 & 1 & 0.18 & 1 \\ 0.554 & -0.496 & 0.413 & -0.37 & 0.36 & -0.322 \\ 0.277 & 0.605 & 0.207 & 0.196 & 0.18 & 0.042 \end{pmatrix}$$

For this sixth-order filter the response falls off much more rapidly than for the second-order filter defined by the array A. Here's a plot of the gain of both filters compared.

$$G2(x) := \text{gain}(C, x)$$



Finally we compute the gain for an FIR filter designed using the function **bandpass**.

Compute coefficients for a length 51 bandpass filter using a Blackman window with passband between f_{low} and f_{high} :

$$f_{\text{low}} := 0.2 \quad f_{\text{high}} := 0.4$$

$$F := \text{bandpass}(f_{\text{low}}, f_{\text{high}}, 51, 6)$$

Filter gain analysis

Chirp z-transform

spectrum minus one. If this number exceeds the maximum array size in your version of Mathcad, an error message results.

- If the total length of the array delivered to the FFT is prime or has few factors, this calculation will be slow.
- The algorithm used is the chirp z-transform described by Samuel Stearns and Ruth David in *Signal Processing Algorithms* (Prentice-Hall, Inc.).

Example

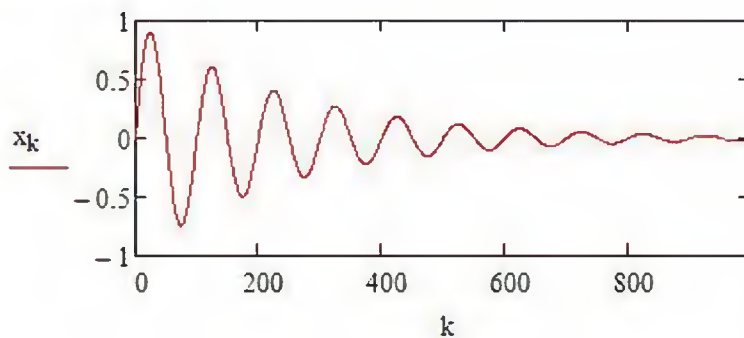
Following an example in Stearns and Ruth, a decaying sine wave signal is created:

$$K := 1000 \quad k := 0..K - 1 \quad f1 := \frac{1}{250} \quad f2 := \frac{1}{100}$$

Sampled signal:

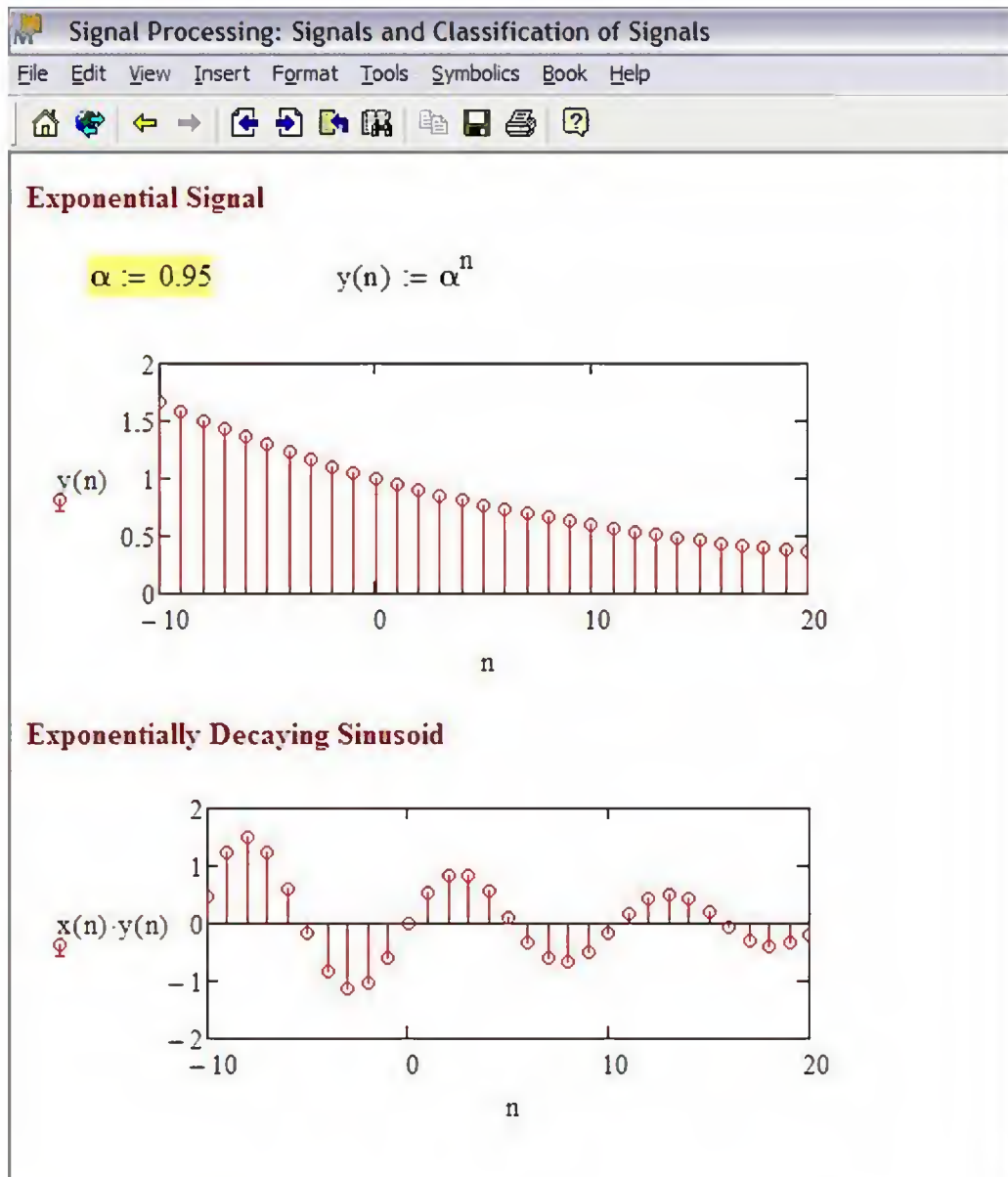
$$x_k := \exp(-f1 \cdot k) \cdot \sin(2 \cdot \pi \cdot f2 \cdot k)$$

Plot of the signal:



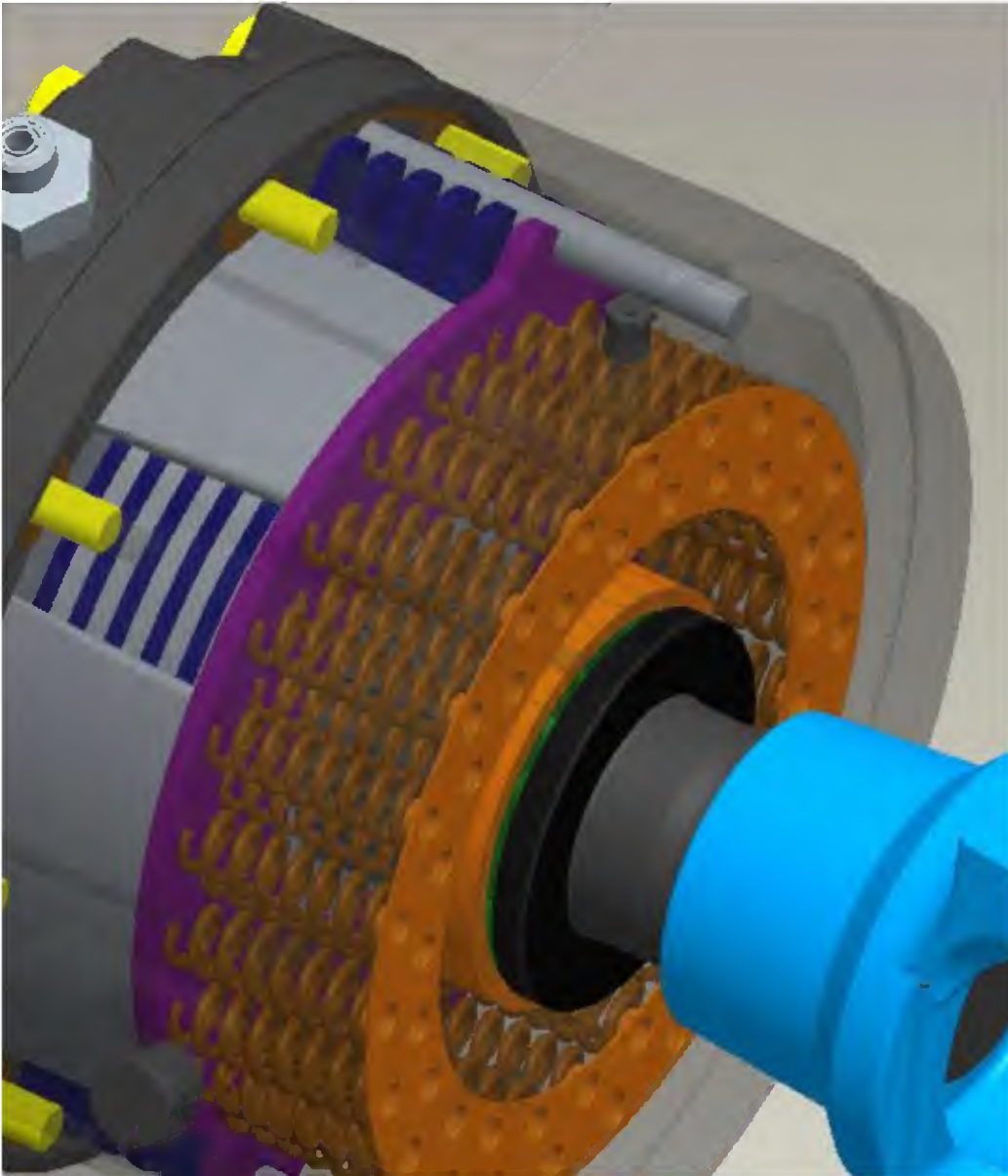
Chirp z-transform

Signal Calculations and Plots



Signal Calculations and Plots

Disk Clutch / Brake



Disk Clutch / Brake

Disk Clutch / Brake

$$F := \pi \cdot \rho_{max} \cdot r_i \cdot (r_o - r_i) \quad F = 8.022 \text{ kN}$$

Friction Torque, Q, integrated over the contact area becomes

$$Q := N_{contact} \cdot \left(\int_{r_i}^{r_o} 2 \cdot \pi \cdot \rho_{max} \cdot r_i \cdot f \cdot r \, dr \right)$$

$$Q := N_{contact} \cdot \frac{2}{3} \cdot \pi \cdot \rho_{max} \cdot f \cdot r_i \cdot (r_o^2 - r_i^2)$$

solving for Q for one pair of contact surfaces then

$$N_{contact} := \frac{Q}{\frac{2}{3} \cdot \pi \cdot \rho_{max} \cdot f \cdot r_i \cdot (r_o^2 - r_i^2)}$$

$$N_{contact} = 10.152$$

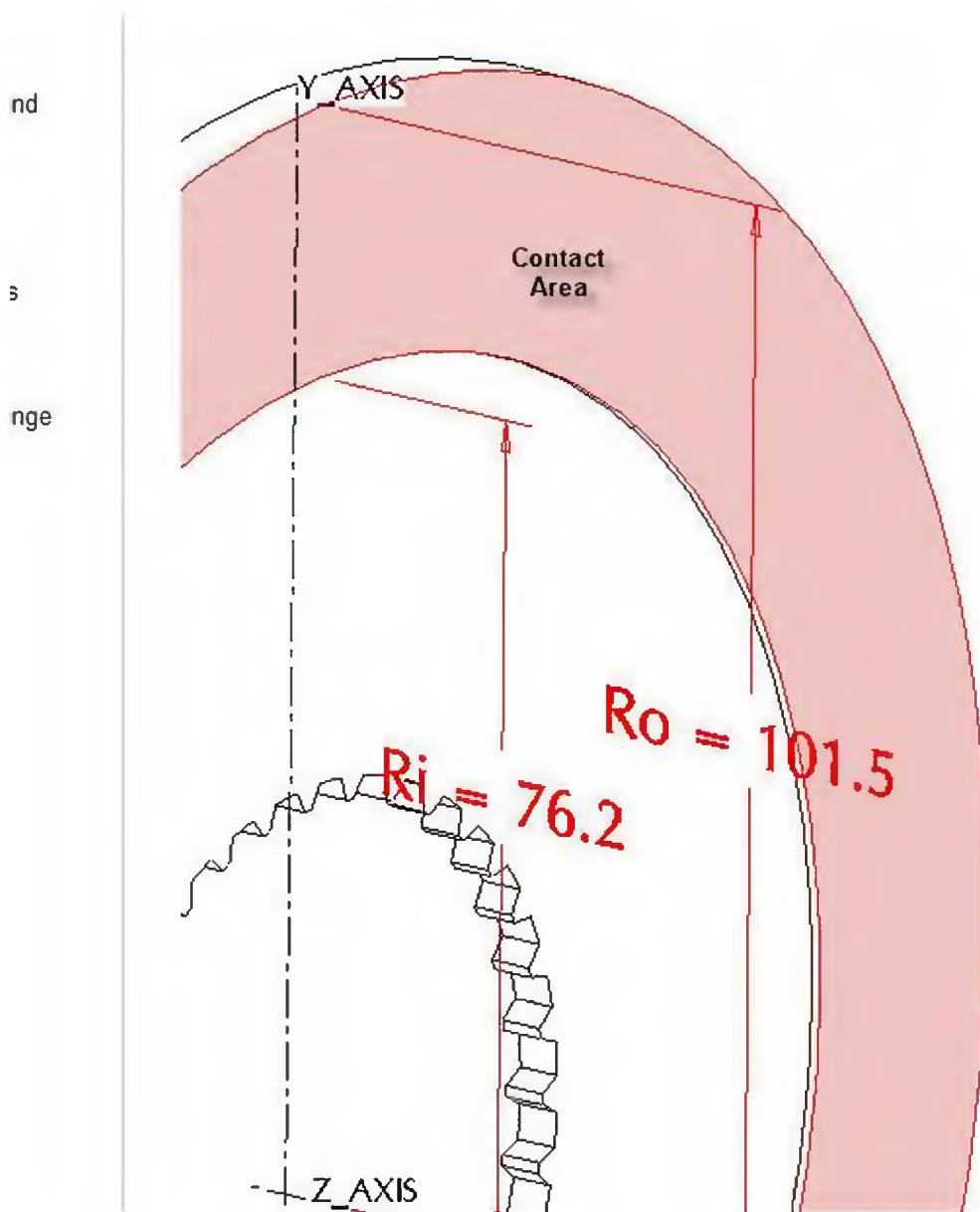
The number of friction surfaces can be divided by 2 to get the number of plate pairs required.

$$NPlates := \text{floor} \left(\frac{N_{contact}}{2} \right)$$

$$NPlates = 5$$

Disk Clutch / Brake

Disk Clutch / Brake



Disk Clutch / Brake

Automotive clutch design equations

Machine Design and Analysis: 1.65 Clutch Selection for Shaft Drive

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2. Determine the required clutch torque starting capacity

A clutch must start its load from a stopped condition. Under these circumstances the instantaneous torque may be two, three, or four times the the running torque. Therefore, the usual clutch is chosen so it has a torque capacity of at least twice the running torque. For internal-combustion engine drives, a starting torque of three to four times the running torque is generally used. Assume 3.5 times is used for this engine and pump combination. This is termed the **clutch starting factor**.

The required starting torque capacity of the clutch is

$$T := \frac{h}{2 \cdot \pi \cdot R}$$

$$T = 10504 \text{ lbf} \cdot \text{in}$$

3. Determine the total required clutch torque capacity

In addition to the clutch starting factor, a service factor is also usually applied. Table 52 (below) lists typical clutch service factors. This tabulation shows that the service factor for a single reciprocating pump is 2.0, or

$$K_f := 2.0$$

Hence, the total required clutch torque capacity is

$$T_c := T \cdot K_f$$

Automotive clutch design equations

Power design calculations

Machine Design and Analysis: 1.84 Power Savings in Hydraulic Systems

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An industrial hydraulic system can be designed with three different types of controls. At a flow rate of 100 gal/min, the pressure drop across the controls is as follows: Control A, 500 psi; control B, 1000 psi; control C, 2000 psi. Determine the power loss and the cost of this loss for each control if the cost of electricity is 15 cents per kilowatt hour. How much more can be spent on a control if it operates 3000 hr/year?

Given parameters

Flow rate: $Q := 100 \cdot \frac{\text{gal}}{\text{min}}$

Pressure loss in A: $\Delta P_A := 500 \cdot \frac{\text{lbf}}{\text{in}^2}$

Pressure loss in B: $\Delta P_B := 1000 \cdot \frac{\text{lbf}}{\text{in}^2}$

Pressure loss in C: $\Delta P_C := 2000 \cdot \frac{\text{lbf}}{\text{in}^2}$

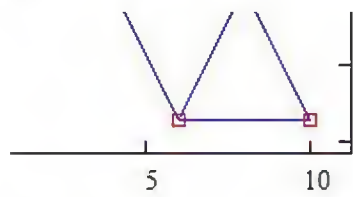
Cost of electricity: $\text{cost} := 0.15 \cdot \frac{\text{dollars}}{\text{kW} \cdot \text{hr}}$

dollars $\equiv 1$

Operation time: $T := 3000 \cdot \frac{\text{hr}}{\text{yr}}$

Power design calculations

Mathcad Mechanical Engineering Library



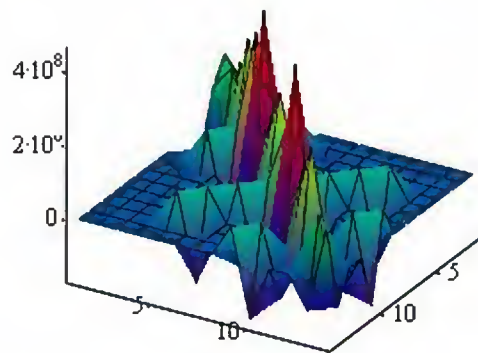
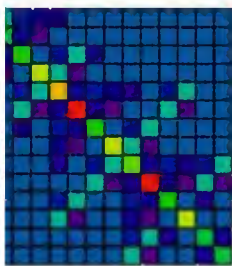
number of elements

$n_{el} = 11$

Truss Members
nodes

Global Stiffness Matrix

bandwidth = 15



K

Element Solution

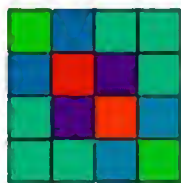
Mathcad Mechanical Engineering Library

Stiffness matrix and graph

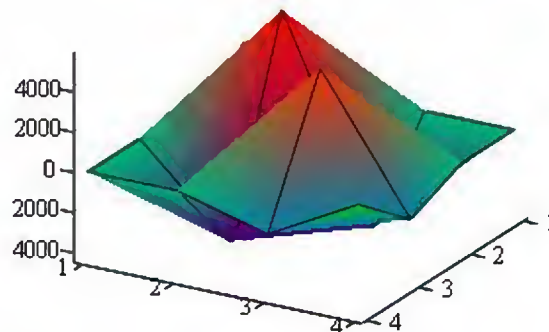
$$K = \begin{pmatrix} 1.5 \times 10^3 & -1.5 \times 10^3 & 0 & 0 \\ -1.5 \times 10^3 & 5.7 \times 10^3 & -4.2 \times 10^3 & 0 \\ 0 & -4.2 \times 10^3 & 5.4 \times 10^3 & -1.2 \times 10^3 \\ 0 & 0 & -1.2 \times 10^3 & 1.2 \times 10^3 \end{pmatrix}$$

Upon examining the assembled stiffness matrix, it can be seen that the half-bandwidth is 2. The surface plot (below) is useful for a quick check on symmetry, and relative magnitudes of the various coefficients.

Figure 3: The Assembled Stiffness Matrix



K



K

Stiffness matrix and graph

Spring calculations

M **Finite Element Beginnings: Step 3: Find the Element Properties**

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2.3 A SYSTEM OF SPRINGS

Section 2.3.3: Step 3: Find the Element Properties

To determine the force-deflection characteristics of an element, consider a free-body diagram of a spring in its most general form of displacement:

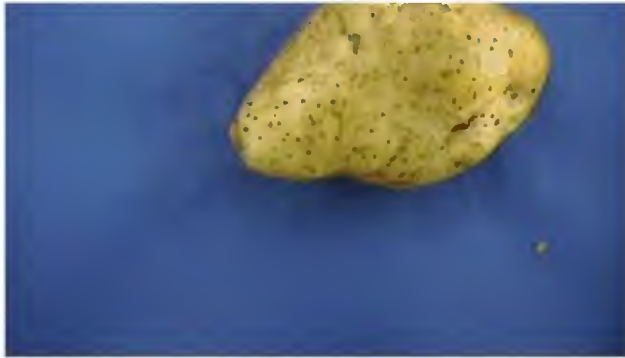
Figure 1: Free-body Diagram of Spring

$L_0 := 1 \cdot \text{m}$	$\delta_{e_2} := 1.25 \cdot \text{m}$	$k_e := 1500 \cdot \text{kN} \cdot \text{m}^{-1}$
$L := 2 \cdot \text{m}$	$\delta_{e_1} := .25 \cdot \text{m}$	$F := 20 \cdot \text{kN}$

The initial and final lengths of the springs are L_0 and L .

Spring calculations

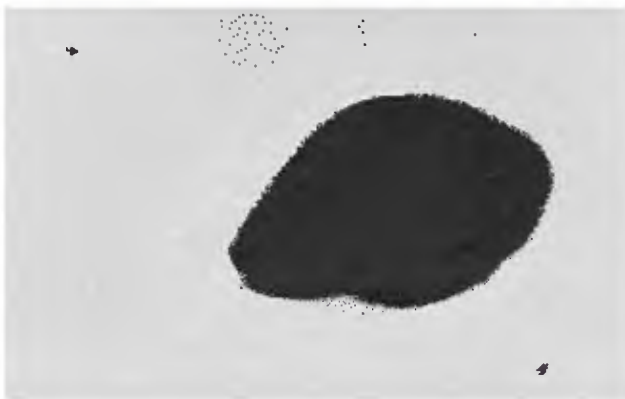
Vision and segmentation



potato

Our first task is to separate the potato from the background in the image. Since it is a color image, one way to separate the regions is to use region color. Region color is quite different, by design, for the potato and the background. One good measure of color is the hue of the HSV representation of the image (see the section on [HSV color](#) for more information):

```
hue_potato := extract(rgb_to_hsv(potato), 1)
```



Vision and segmentation

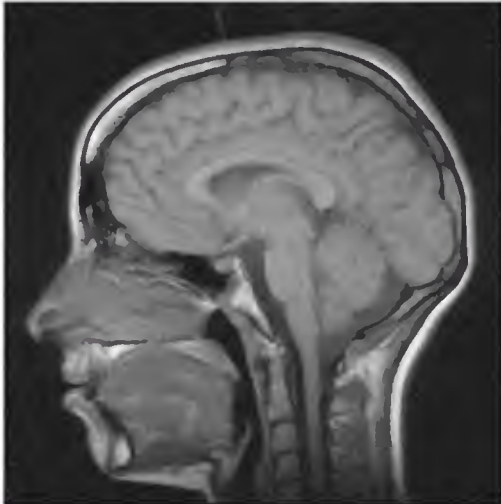
Canny edge detector

complete disappearance of edges corresponding to objects with no pixel on a connected edge of intensity greater than **high**.

Next we show applications of Canny's edge detection on natural images.

```
R := READ_IMAGE("brain.gif")
```

```
E := canny(R, 1.0, 5, 10)
```



R



E-255

Application of this algorithm on the brain image, above, shows that it can detect the most salient edges on the image, including boundaries of the head and the boundaries of the brain. By adjusting the values of the various parameters, we can get more or less detail, as needed.

Now let's apply the algorithm to a fingerprint image:

Canny edge detector

Blending and masking

reblending backgrounds, which improves feature visibility. Masking can be used to black out part of an image so that processing can be done on the remaining features.

Arguments

- **M**, the first image matrix
- **N**, the second image (or mask) matrix, the same size as the first.

The functions return an image matrix which contains the sum of M and N, or the mask of M with N, clipped at 255.

Function Details **blend(M, N)**

This function combines two images M and N of the same size, using the formula

$$(M + N) - \frac{M \cdot N}{255}$$

As you can see, when an element of either M or N is 255 this formula returns 255, which is the desired clipping response. When M or N is zero, the function returns only the remaining element.

$$Q := \begin{pmatrix} 10 & 20 & 0 \\ 123 & 59 & 255 \\ 20 & 25 & 0 \end{pmatrix} \quad R := \begin{pmatrix} 0 & 225 & 255 \\ 10 & 255 & 0 \\ 225 & 255 & 0 \end{pmatrix}$$

$$\text{blend}(Q, R) = \begin{pmatrix} 10 & 227.35294 & 255 \\ 128.17647 & 255 & 255 \\ 227.35294 & 255 & 0 \end{pmatrix}$$

Blending and masking

Adding and measuring noise

$$N = \begin{pmatrix} 127 & 177 & 77 & 77 & 77 \\ 127 & 127 & 77 & 127 & 127 \\ 177 & 177 & 177 & 77 & 127 \\ 177 & 127 & 177 & 177 & 177 \\ 177 & 127 & 127 & 127 & 77 \end{pmatrix}$$

Applied to a real image matrix:

```
M := READ_IMAGE("camera.bmp") N := addnoise(M, .3, 150)
```



M



N

To see the effect of the noise mathematically, look at the difference between the histograms of the two images:

```
H := HISTOGRAM(M) H2 := HISTOGRAM(N)
```

Adding and measuring noise

Crisping

$$\begin{pmatrix} 1 & -2 & 1 \end{pmatrix}$$

To economize on memory, do the calculations in one step:

```
dia := equalize(scale(diacrisp(R), 0, 255))
```

unicrisp(M)

Kernel:

$$\begin{pmatrix} -1 & -1 & -1 \\ -1 & 9 & -1 \\ -1 & -1 & -1 \end{pmatrix}$$

```
uni := equalize(scale(unicrisp(R), 0, 255))
```



dia



uni

Crisping

Chebyshev polynomial equations

$$w := C \cdot c$$

The approximating polynomial is

$$P(y) := \sum_k (w_k \cdot y^k)$$

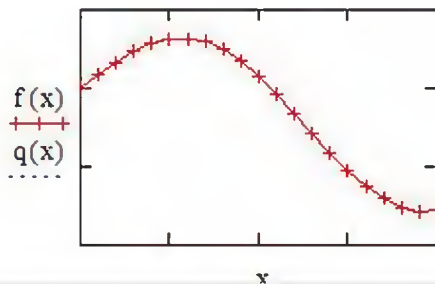
The coefficients of the powers of x in the approximation to f(x) over the interval [a, b] are given by

$$j := 0..N \quad d_k := \sum_j \text{if} \left[(k < j) \cdot (k > 0), w_j \cdot r^k \cdot s^{j-k} \cdot \frac{j!}{k! \cdot j - k!}, 0 \right]$$

The approximating polynomial, and explicit coefficients are shown below.

$$q(x) := \sum_k (d_k \cdot x^k)$$

k =	d _k =
0	0
1	22.798
2	-3.385
3	0.271
4	-0.04
5	5.614 · 10 ⁻³
6	0













Chebyshev polynomial equations


Solving equations for convergence

Topics in Electrical Engineering: Section 11.1 Transform/Inverse Transform

File Edit View Insert Format Tools Symbolics Book Help

Region of Convergence

 For the transform to converge, that is, for the frequency response to be defined in the complex z-plane, the following relationship must hold:

$$\sum_n \left[|x(n)| \cdot (|r \cdot z|)^{-n} \right] < \infty$$

For example, the transform of the unit step function

$$H(z) = \frac{z}{z - 1}$$

will only converge for values of $|z|$ or $|r| > 1$ (greater than the value of the poles). Remember that if you represent the z-transform of an *infinite* sequence by a *finite* sum in Mathcad, the sum will behave differently from the true z-transform. For example, it may converge at a pole of the transform, when the closed-form expression would yield a singularity.

$$x(n) := 1 \quad n := 1..15 \quad X(z) := \sum_n \left(x(n) \cdot z^{-n} \right)$$

Notice that this sum is explicit only over the range 1 to 15, but the ideal step function sequence is *infinite*. Examine the effect of the variable r on the graph below.

Solving equations for convergence

Deconvolution equations for electrical engineering applications

adding a small safety factor to each term of the denominator.

$$\varepsilon := 10^{-6} \quad (\text{a small safety factor})$$

The deconvolution is given by

$$x' := \frac{\sqrt{N}}{2 \cdot T_0} \cdot \operatorname{Re} \left(\operatorname{icfft} \left(\frac{\operatorname{cfft}(y)}{\operatorname{cfft}(h) + \varepsilon} \right) \right)$$

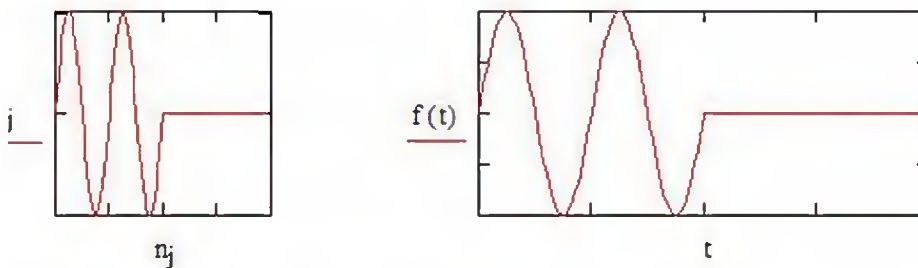


fig. 8.2 Deconvolved signal compared with original signal

The plot shows that the sequence given by the deconvolution matches the original sampled input function f . Notice that the interpolation is not really necessary with this many points, since the original sampling function will connect them smoothly anyway.

Discrete Convolution of Two Finite Sequences

This example uses Mathcad's **sum** and **mod** operators to find the discrete convolution of two finite sequences. The document reads in the two sequences to be convolved from files **signal1.prn** and **signal2.prn** and stores them in the arrays **S1** and **S2**, respectively.

Deconvolution equations for electrical engineering applications

Network analysis reference information

The voltages (or currents) in a linear RLC network can be determined between each node by applying Kirchoff's voltage and current laws to the various impedances. The simultaneous system of equations developed in this way can be expressed as a single matrix equation, and solved in a straightforward manner using matrix arithmetic. The matrix of interest is the admittance matrix, whose elements are the admittances associated with each pair of nodes.

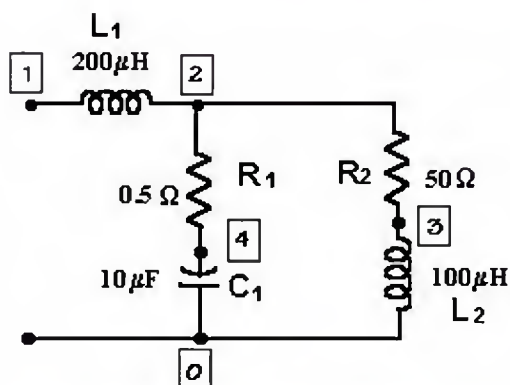


Fig. 4.1 A sample network. This example is a four node circuit, requiring a 4-by-4 admittance matrix.

Admittances for the various elements are simply the inverses of their impedances. The expressions for inductors and capacitors should be expressed in terms of the operating frequency for the circuit. Using the admittance matrix, it is possible to find the resonant frequency for the network, and the general frequency response. Admittance formulae for capacitors and inductors are shown below:

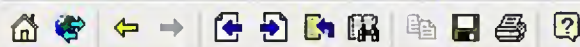
$$Y_C(\omega) = j \cdot \omega \cdot C \qquad Y_L(\omega) = \frac{1}{j \cdot \omega \cdot L}$$


Network analysis reference information

Electrical engineering reference

M Topics in Electrical Engineering: Section 9 Digitizing a Signal

File Edit View Insert Format Tools Symbolics Book Help



+


APPLICATIONS IN SIGNAL PROCESSING

Section 9 Digitizing a Signal

This document digitizes continuous or sampled signals. You input:

- $F(t)$, the calculated or sampled continuous-time signal
- Δ , the sampling interval
- ω , the bandwidth limit of the signal

The output is a vector of integers representing the quantized level assigned to each digitized sample. The document plots the original samples, the quantized output, and the quantizing noise.

References

William McC. Siebert, *Circuits, Signals, and Systems*,
The MIT Press (Cambridge, 1986).

Background

It is often desirable to convert a continuous-time signal into a set of digital samples. The signal can now be processed by digital circuitry, and will be easier to store and recall. This type of

Electrical engineering reference

Calculating Linear Regressions

the term in order to be considered a linear fit. Consider the following data:

data :=

	0	1
0	1	4.18
1	2	...

$$X := \text{data} \langle 0 \rangle \quad Y := \text{data} \langle 1 \rangle$$

Enter the vector of functions to fit.

$$F1(x) := \begin{pmatrix} \ln(x) \\ \sqrt{x} \\ 1 \end{pmatrix}$$

Call the **linfit** function using the data and the vector of functions, F.

$$\text{params} := \text{linfit}(X, Y, F1)$$

Define a function that uses these newly found parameter values in the logarithmic model. Also, define a range variable over which to graph the function.

$$f(x) := F1(x) \cdot \text{params} \quad z := \min(X) .. \max(X)$$

A graph of the model function with the newly found parameter values and the original data points reveals a good fit.



Calculating Linear Regressions

Quantile Plots

axis (y), and the first column will be plotted on the outer (x).

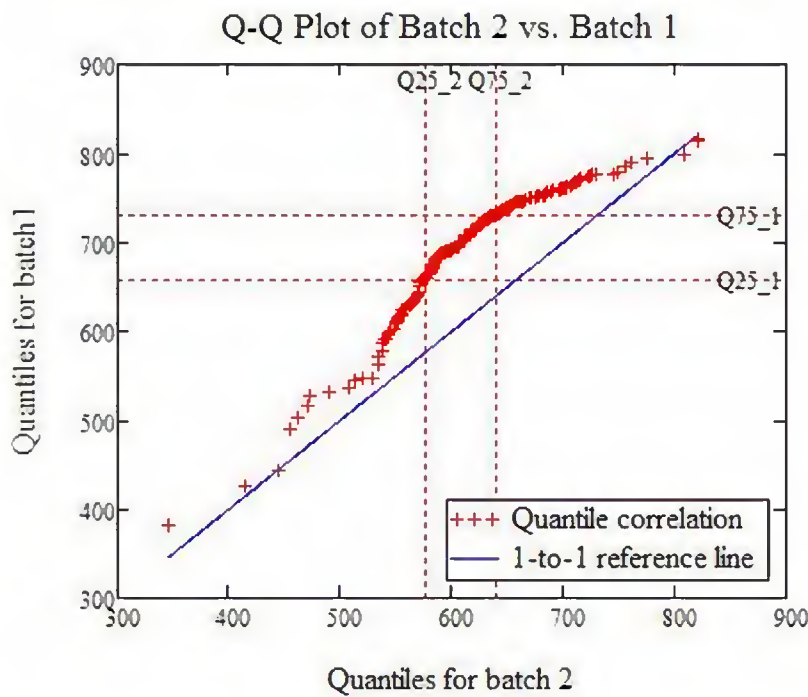
```
Batchplot := qqplot(batch2, batch1) x := min(batch2)..max(batch2)
```

Calculate some quantiles for markers on the plot:

```
Q25_1 := percentile(batch1, 0.25)    Q75_1 := percentile(batch1, 0.75)
Q25_2 := percentile(batch2, 0.25)    Q75_2 := percentile(batch2, 0.75)
```

$$\begin{pmatrix} Q25_1 & Q75_1 \\ Q25_2 & Q75_2 \end{pmatrix} = \begin{pmatrix} 659.51 & 731.4455 \\ 576.84225 & 640.34325 \end{pmatrix}$$

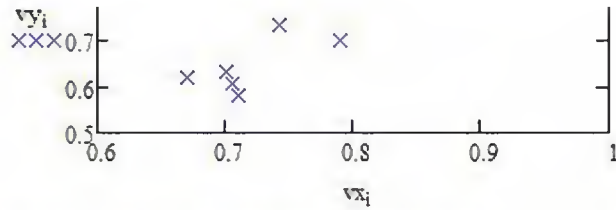
Quantiles for batch 1 are shifted higher than they are for batch 2.



Comparing the quantiles, or percentiles, of these two batches

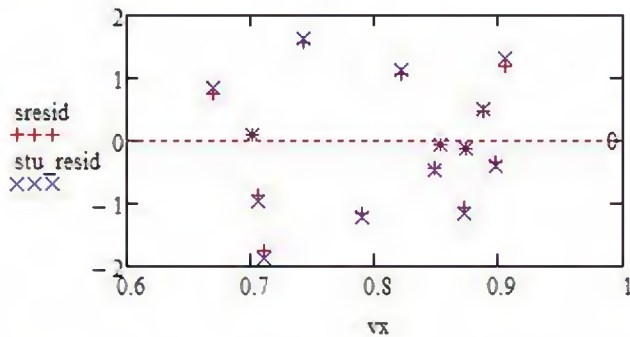
Quantile Plots

Residual Analysis



and had a high **correlation coefficient**, $\text{corr}(vx, vy) = 0.956027$

If the data are, in fact, linearly related, and the errors are normally distributed, a scatterplot of the standardized (or studentized) residuals versus either the x values or the predicted y values will have no discernible pattern. The points will be randomly scattered about the hypothesized error mean of zero.



Residual Analysis

Cubic Spline Calculations

$$vx := Cu^{(1)} \quad vy := Cu^{(0)}$$

$$paramsc := cspline(vx, vy)$$

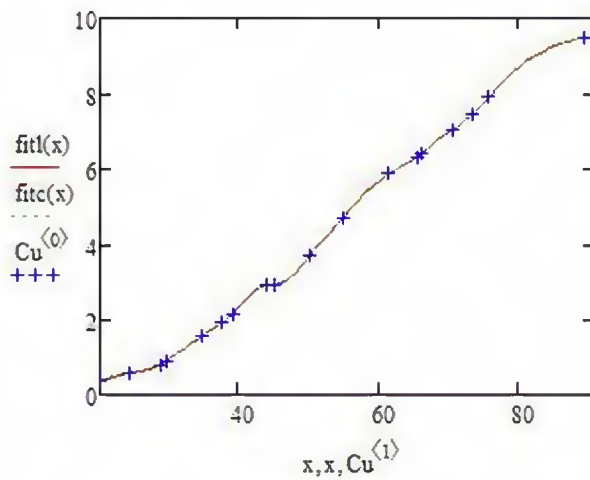
$$paramsl := lspline(vx, vy)$$

These functions return a vector which contains the values of the second derivative of the desired spline at each point of \mathbf{Mx} . Pass the output to the interp function to generate the interpolated values.

$$fitc(x) := interp(paramsc, vx, vy, x)$$

$$fitl(x) := interp(paramsl, vx, vy, x)$$

$$x := \min(vx) .. \max(vx)$$

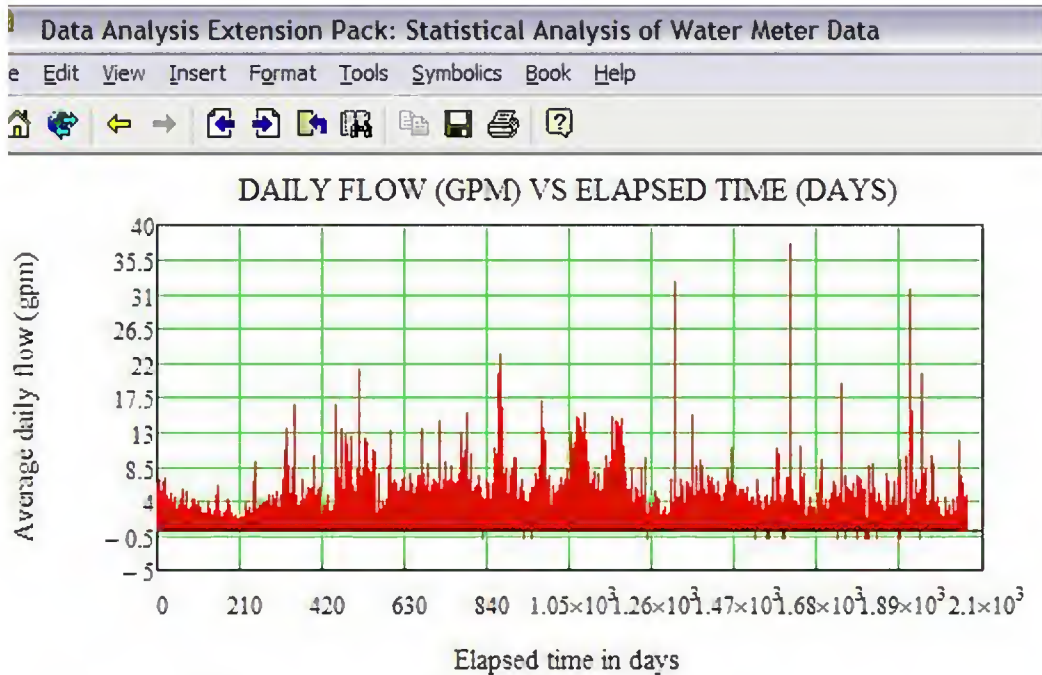


Derivatives

You may also wish to know the derivatives of the spline fit, to find maxima and minima, slope, or other features.

Cubic Spline Calculations

Statistical Analysis



The raw data exhibits no obvious changes in pattern. There were about 20 days where flow data were not available and these were given the value -1

We first need to deal with the -1 values. There is no generally accepted way of doing this. If they are removed, the data set is discontinuous, which is undesirable. In this case I will first remove the -1 values to create another set of "real" values. Then I will compute the mean of that data set. Finally, I will substitute the median value of that data set for all -1 values in the original data set. In this way I have a continuous data set (not a perfect solution, but this is the real world!) with no missing values.

Get all the indices of the data which are of value -1:

Statistical Analysis

Shear analysis

Building Structural Design: 6.2 Design of Flat Plates for Shear

File Edit View Insert Format Tools Symbolics Book Help

Calculations

Shear Section at Interior Column Type 1

Shear Section at Exterior Column Type 2

Shear Section at Corner Column Type 3

Plan dimensions of the critical shear area (ACI 318, 11.12.1.2):

$$x := \text{if} \left[(T = 1) + (T = 2), C_x + d_y, C_x + \frac{d_y}{2} + x_o \right] \quad x = 24.25 \text{ in}$$

$$y := \text{if} \left(T = 1, C_y + d_x, C_y + \frac{d_x}{2} + y_o \right) \quad y = 21.25 \text{ in}$$

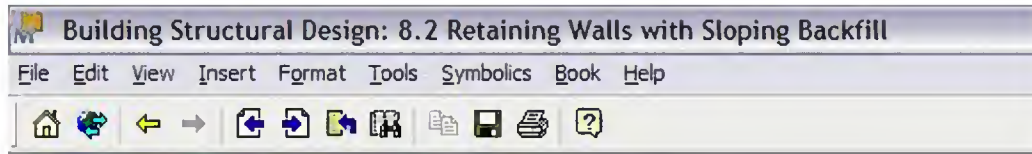
Shear section area (ACI 318, 11.12.2.1 and Fig. R11.12.6.2 of ACI Commentary):

$$A_c := \text{if} \left(T = 1, 2 \cdot x \cdot d_x + 2 \cdot y \cdot d_y, \text{if} \left(T = 2, x \cdot d_x + 2 \cdot y \cdot d_y, x \cdot d_x + y \cdot d_x \right) \right)$$

$$A_c = 423.25 \text{ in}^2$$

Shear analysis

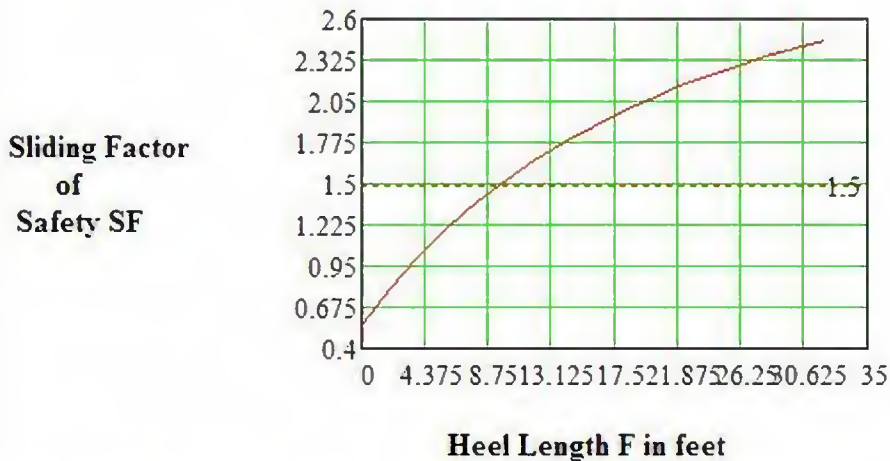
Retaining wall design calculations



Check feasibility of proposed design

For some walls with a steep sloping backfill and a low sliding resistance, there may be no feasible base length. A plot of the factor of safety against sliding with $T = F/2$, versus heel length F will show if a practical design is feasible:

$$F := 0\text{-ft}, 2\text{-ft} .. 1.5 \cdot H \quad f(F) := \frac{c_f \cdot w_R \left(F, \frac{F}{2} \right)}{P_{ah}(F)}$$



If the required factor of safety for sliding cannot be provided with a practical heel length the backfill slope must be reduced, or the sliding resistance must be increased. If necessary, a base shear lug can be

Retaining wall design calculations

Calculate spread footing performance

Building Structural Design: 7.1 Spread Footings

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Calculations

Net soil bearing pressure at factored load:

$$q_u := F \cdot q_s \quad q_u = 20.15 \text{ ksf}$$

The number of footings to be designed N , and range variable i :

$$N := \text{length}(X) \quad N = 5 \quad i := 0..N - 1$$

Total service load capacity:

$$P_s := q_s \cdot X \cdot Y$$

$$P_s^T = (5.2 \times 10^3 \quad 2.496 \times 10^3 \quad 1.872 \times 10^3 \quad 780 \quad 325) \text{ kip}$$

Total factored load capacity:

$$P_u := q_u \cdot X \cdot Y$$

$$P_u^T = (8.06 \times 10^3 \quad 3.869 \times 10^3 \quad 2.902 \times 10^3 \quad 1.209 \times 10^3 \quad 503.75) \text{ kip}$$

Footing projections from face of pier:

$$a_{fx} := \frac{X - C_x}{2}$$

$$a_{fx}^T = (0 \quad 6.5 \quad 4.75 \quad 4 \quad 1.75) \text{ ft}$$

$$Y - C_y$$

Calculate spread footing performance

Design Spread Footings

Building Structural Design: 7.1 Spread Footings

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Input

Notation

PLAN

ELEVATION

Input Variables

Allowable net soil bearing pressure at service load: $q_s := 13 \cdot \text{ksf}$

Column or wall width: $C_x := (240 \ 36 \ 30 \ 24 \ 18)^T \cdot \text{in}$

Column depth: $C_y := (48 \ 32 \ 144 \ 12 \ 18)^T \cdot \text{in}$

Footing width: $X := (20 \ 16 \ 12 \ 10 \ 5)^T \cdot \text{ft}$

Footing length: $Y := (20 \ 12 \ 12 \ 6 \ 5)^T \cdot \text{ft}$

Computed Variables

.....

Design Spread Footings

Column strength calculations

Reinforcement strength: $f_y = 60 \text{ ksi}$

Weight of concrete: $w_c = 147 \text{ pcf}$

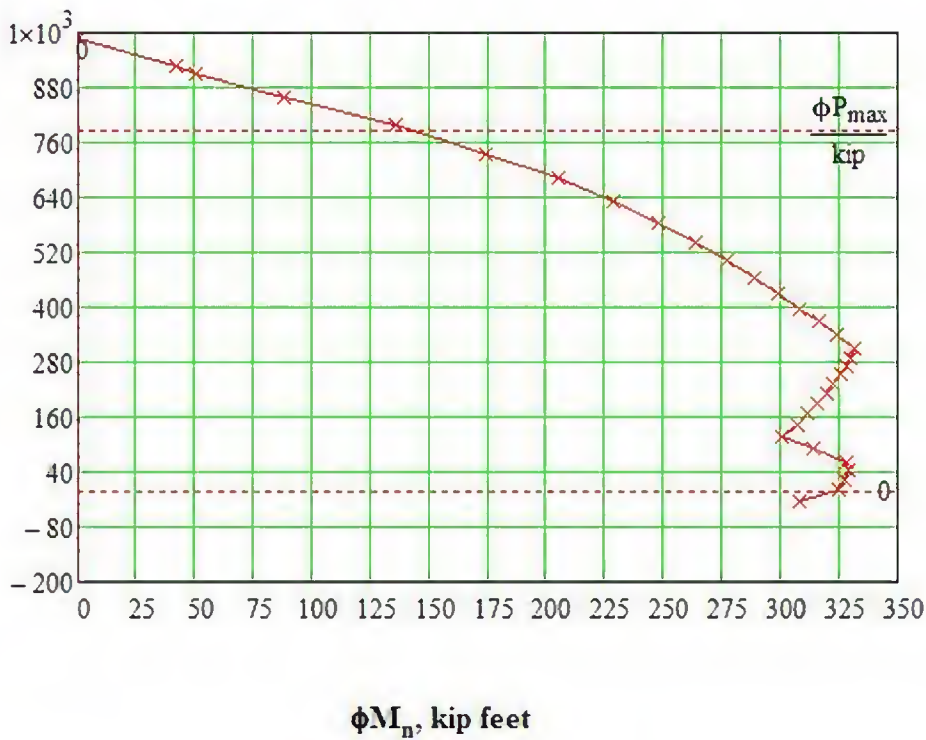
Number of bars

used: $N_b = 2$

Maximum usable

axial load: $\phi P_{max} = 789.9 \text{ kip}$

Area of reinforcement: $A_{st} = 7.62 \text{ in}^2$



Column strength calculations

Beam calculations

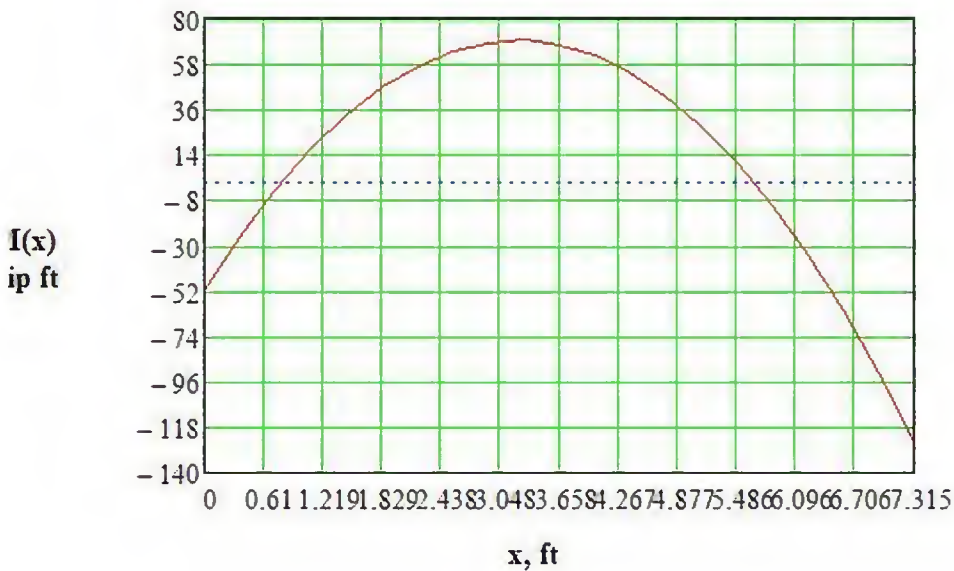
distance x from the
: end: $V(x) := R_L - w \cdot x$

oment as a function
distance x from the
: end: $M(x) := -M_L + R_L \cdot x - \frac{1}{2} \cdot w \cdot x^2$

maximum positive
(least negative)
moment at distance x
from the left end: $M_{max} := M(X_0) \quad M_{max} = 69.162 \text{ kip} \cdot \text{ft}$

Plot of Moment M(x) versus x for N Points Across the Span

$N := 20 \quad x := 0 \cdot \text{ft}, \frac{L}{N} \dots L$



Beam calculations

Change inputs and instantly recalculate results

Mathcad Calculation Server Example Worksheets - Microsoft Internet Explorer

Address: <http://mcs.atc.com/mcs/worksheets/MWegaugae.xmcd>

Mathcad Calculation Server

American Wire Gauge (AWG) Table

This table calculates the resistance per unit length for copper wire as a function of the AWG number (cross section), the temperature, and the frequency. Resistance is calculated for DC and high frequency current, which includes skin effect. Resistances are generated from extrapolation formulas that reproduce the AWG measured value within 1%.

Choose a wire gauge: Enter a temperature (0 to 100°C): °C Enter a frequency: kHz

Click 'Recalculate' to update the worksheet

Wire diameter: $DIAM(w) = 0.1289 \text{ cm}$

Cross-sectional area: $AREA(w) = 0.211474 \text{ cm}^2$

Current producing 450 amp/cm squared is: $CURR(w) = 95.163 \text{ amp}$

DC Resistance **High Frequency Resistance**

$RES(D, T) = 3.18 \times 10^{-1} \frac{\Omega}{\text{cm}}$ Skin depth at this frequency: $\delta(T, f) = 0.662 \text{ -mm}$

Diameter for chosen AWG: $DIAM(w) = 0.1289 \text{ -cm}$

Resistance per unit length at frequency f : $SRES(D, T, f) = 1.6 \frac{\Omega}{\text{cm}}$

References

Siemens Components XIX (1984), No. 5: The Skin Effect
 Donald G. Fink and H. Wayne Beaty, *Standard Handbook for Electrical Engineers*, McGraw-Hill Book Company (New York, 1987)

Handbook of Mathematical and Scientific, and Engineering Formulas,
 Research and Education Association (New York, 1984)

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Change inputs and instantly recalculate results

Quickly customize calculation variables

The screenshot shows a web browser window displaying the Mathcad Calculation Server interface. The page title is "Mathcad Calculation Server Example Worksheets - Microsoft Internet Explorer". The address bar shows the URL: <http://mcs.pts.com/mcs/worksheets/OpticsCatalog.xmcd>.

The main content area is titled "PROPERTIES OF OPTICAL MATERIALS" and is sourced from "Metres Grid Optics Catalog". It includes instructions: "Choose the material with the right index for your application, then order components" and "Using tables of measured refractive index values, refractive index at any wavelength between 180nm and 2.5µm calculated measured values are shown on the graph below".

A dropdown menu for "Choose a material:" is open, showing options: "Synthetic Fused Silica", "Synthetic Fused Silica", "BK7", and "LaSF 9". A "Recalculate" button is visible next to the dropdown.

Below the dropdown, there is a text input field for the operating wavelength: λ_0 714 nm. A "Choose operating wavelength" label is next to it.

The graph plots "Refractive Index" on the y-axis (ranging from 1.4 to 1.6) against "Wavelength (nm)" on the x-axis (ranging from 0 to 2.5 x 10³). A red curve shows the refractive index decreasing as wavelength increases. A blue diamond marker is placed on the curve at approximately 714 nm, with a callout box displaying: $\lambda_0 = 714 \text{ nm}$ and $n_0 = 1.45499$.

At the bottom of the page, a footer reads: "This web page is running on a Mathcad Calculation Server and was archived with Mathcad software. Copyright © 2006, Parametric Technology Corporation. All Rights Reserved."

Quickly customize calculation variables

Share industry standard calculations

Mathcad Calculation Server Example Worksheets - Microsoft Internet Explorer

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Calculation Server

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- Example Worksheets
- Browser Settings

Civil Engineering Solved Problems

Steel Design: Beam Design

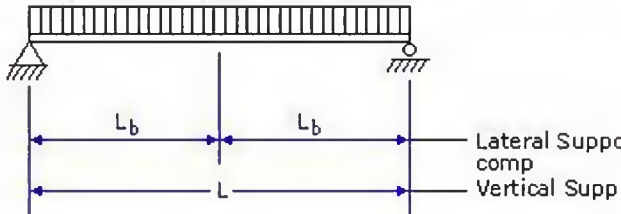
Introduction

This worksheet can be used to design a simply support lateral bracing, supporting a uniform distributed load by

There are **two input sections** in this worksheet: one below for setting **AISC dimensions and properties** a course of developing a solution.

Statement

Select the lightest W section of A36 steel to support a span of length L . The beam is braced at the supports



Share industry standard calculations

Easily change inputs to calculations

Mathcad Calculation Server Example Worksheets - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address http://mcs.ptc.com/mcs/worksheets/drum_xmcd

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Home
Example Worksheets
Browser Settings

Vibrating Drum Head

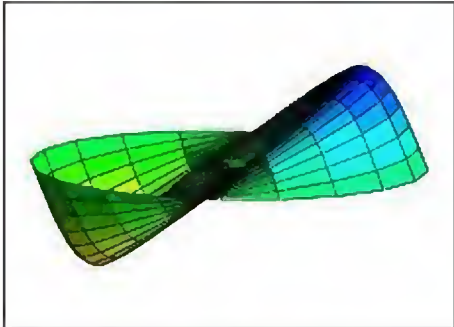
A drumhead is a circular vibrating membrane restricted by the condition that its movement and position at the edges is zero. The solution to the partial differential equation that describes its modal vibration is given by Bessel functions.

time: Pick a different time in the drum's cycle of oscillation to see the deformation in the surface at that time.

mode: 1 2 3 Pick a different mode to see how higher order modes resonate on the drum's surface. The n=1 mode will be dominant, but higher modes result in harmonics in tone.

cycle = 20
$$f(x) = J_n(\text{mode}, x) \cos\left(\frac{\pi}{\text{cycle}} 2 \cdot n\right)$$

The mode looks like this



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Easily change inputs to calculations

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Mathcad Calculation Server Home Page

Example Worksheets

The [Mathcad Calculation Server](#) examples that follow demonstrate distributing math-related solutions. For example, with the

- Share results with Mathcad and non-Mathcad users
 - [Motion of a Drum Head](#)
- Give access to mathematically-oriented catalog, pre
 - [Optical Properties: Materials Catalog selector](#)
 - [American Wire Gauge Table](#)
- Centralize time-intensive, repetitive, or verification c
 - [Van Der Pol Equation](#)
 - [Rational Function Data Fit Metrics](#)
 - [Digital Elliptic Lowpass Filter](#)
- Educate using interactive examples:
 - [Projectile Motion](#)
 - [Steel Design: Beam Design](#)

Education Examples

For more examples, see the [Mathcad Calculation Server in](#)

Access content via a web browser