```
(* Lecture 1 1-10-2019
```
   1.1 *Mathematica* as a calculator *)

```
(*bracts ([{*)

N

N[123 + 13 / (5 * 2)]
6 / 7
123 + 13 / (5 * 2) // N
N[%%]
```

124.3

$\frac{6}{7}$

124.3

0.857143

```
5^2
Sqrt[8] // N
Sqrt[8.]
```

25

2.82843

2.82843

```
(*Ex1
```
$$2682440^4 + 15365639^4 + 18796760^4 = 20615673^4,$$ *)

$2\,682\,440^4 + 15\,365\,639^4 + 18\,796\,760^4$
$20\,615\,673^4$

180 630 077 292 169 281 088 848 499 041

180 630 077 292 169 281 088 848 499 041

```
x1 = 2682440^4 + 15365639^4 + 18796760^4;
x2 = 20615673^4;
x1 == x2
x1
```

True

180630077292169281088848499041

```
Clear[x1, x2]
x1
```

```
N[Pi, 100]
```

3.141592653589793238462643383279502884197169399375105820974944592307816406286208998628034825342117068

```
Tan[Pi / 4];
```

```
x = Pi / 3; y = Pi / 5;
Tan[x] + Cos[y] // N
Tanh[x]
Coth[x]
Sech[y]
ArcTan[x]
ArcSinh[y]
```

2.54107

$\mathrm{Tanh}\left[\frac{\pi}{3}\right]$

$\mathrm{Coth}\left[\frac{\pi}{3}\right]$

$\mathrm{Sech}\left[\frac{\pi}{5}\right]$

$\mathrm{ArcTan}\left[\frac{\pi}{3}\right]$

$\mathrm{ArcSinh}\left[\frac{\pi}{5}\right]$

```
u = {1, 2, 3, 4, 5}
```

{1, 2, 3, 4, 5}

```
Log10[10.]
Log[10.]
```

1.

```
Clear[x];
x = 1.
Exp[x]
```

```
1.
```

```
2.71828
```

```
1
```

```
1
```

```
2^5 + 3.4 + 2.5^2;
Tan[Pi / 6.];
Sin[Pi / 5.];
Cos[Pi / 5];
Sqrt[16];
N[%%%]
5 / 3
N[5 / 3]
```

```
0.587785
```

$\frac{5}{3}$

```
1.66667
```

```
?? N
```

N[*expr*] gives the numerical value of *expr*.
N[*expr*, *n*] attempts to give a result with *n*-digit precision. >>

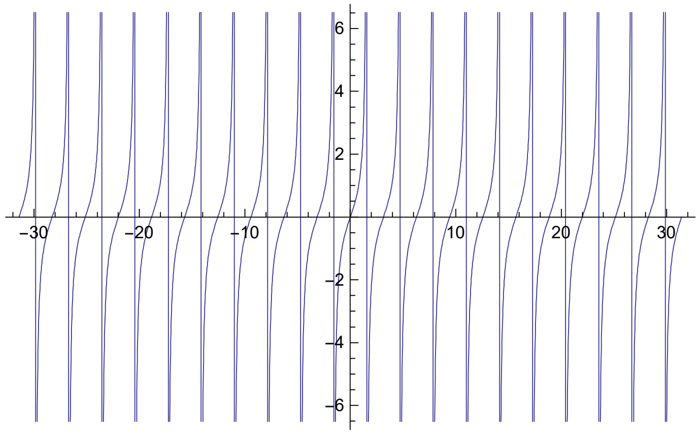
```
Attributes[N] = {Protected}
```

```
N /: Default[N, 2] := {MachinePrecision, MachinePrecision}
```

```
? Plot
```

Plot[f, {x, x_{min}, x_{max}}] generates a plot of f as a function of x from x_{min} to x_{max}.
Plot[{f_1, f_2, …}, {x, x_{min}, x_{max}}] plots several functions f_i. >>

```
Plot[Tan[x], {x, -10 Pi, 10 Pi}]
```




```
?? Plot
```

Plot[f, {x, x_{min}, x_{max}}] generates a plot of f as a function of x from x_{min} to x_{max}.
Plot[{f_1, f_2, …}, {x, x_{min}, x_{max}}] plots several functions f_i. ≫

```
Attributes[Plot] = {HoldAll, Protected, ReadProtected}

Options[Plot] = {AlignmentPoint → Center, AspectRatio → 1/GoldenRatio, Axes → True, AxesLabel → None,
  AxesOrigin → Automatic, AxesStyle → {}, Background → None, BaselinePosition → Automatic,
  BaseStyle → {}, ClippingStyle → None, ColorFunction → Automatic, ColorFunctionScaling → True,
  ColorOutput → Automatic, ContentSelectable → Automatic, CoordinatesToolOptions → Automatic,
  DisplayFunction :→ $DisplayFunction, Epilog → {}, Evaluated → Automatic,
  EvaluationMonitor → None, Exclusions → Automatic, ExclusionsStyle → None, Filling → None,
  FillingStyle → Automatic, FormatType :→ TraditionalForm, Frame → False, FrameLabel → None,
  FrameStyle → {}, FrameTicks → Automatic, FrameTicksStyle → {}, GridLines → None,
  GridLinesStyle → {}, ImageMargins → 0., ImagePadding → All, ImageSize → Automatic,
  ImageSizeRaw → Automatic, LabelStyle → {}, MaxRecursion → Automatic, Mesh → None,
  MeshFunctions → {#1 &}, MeshShading → None, MeshStyle → Automatic, Method → Automatic,
  PerformanceGoal :→ $PerformanceGoal, PlotLabel → None, PlotLegends → None, PlotPoints → Automatic,
  PlotRange → {Full, Automatic}, PlotRangeClipping → True, PlotRangePadding → Automatic,
  PlotRegion → Automatic, PlotStyle → Automatic, PreserveImageOptions → Automatic,
  Prolog → {}, RegionFunction → (True &), RotateLabel → True, TargetUnits → Automatic,
  Ticks → Automatic, TicksStyle → {}, WorkingPrecision → MachinePrecision}
```

```
?? Cos
```

Cos[z] gives the cosine of z. ≫

```
Attributes[Cos] = {Listable, NumericFunction, Protected}
```

```
? N
```

N[*expr*] gives the numerical value of *expr*.
N[*expr*, n] attempts to give a result with n-digit precision. ≫

```
N[24 / 17, 100]
24. / 17
```

```
1.41176470588235294117647058823529411764705882352941176470588235294117647058823529411764
  7058823529412
```

```
1.41176
```

```
N[Pi, 100]
```

```
3.14159265358979323846264338327950288419716939937510582097494459230781640628620899862803
  4825342117068
```

```
Pi
```

π

```
N[Pi, 200]
```

```
3.14159265358979323846264338327950288419716939937510582097494459230781640628620899862803
  482534211706798214808651328230664709384460955058223172535940812848111745028410270193852
  11055596446229489549303820
```

$$\sqrt{(\frac{\pi}{4})^2 + (0.5\ \mathrm{Log}[2])^2},$$

```
Sqrt[(Pi / 4)^2 + (0.5 Log[2])^2]
0.858466
```

$$\mathrm{N}\left[\sqrt{\left(\frac{\pi}{4}\right)^2 + \left(\frac{1}{2}\mathrm{Log}[2]\right)^2}\right]$$

```
N[%]
```

$$\sqrt{\left(\frac{\pi}{4}\right)^2 + \left(\frac{1}{2}\mathrm{Log}[2]\right)^2} \ // \ \mathrm{N}$$

```
0.858466
```

```
0.858466
```

```
0.858466
```

```
? N
```

N[*expr*] gives the numerical value of *expr*.
N[*expr*, *n*] attempts to give a result with *n*-digit precision. ≫

```
?? N
```

N[*expr*] gives the numerical value of *expr*.
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```
Attributes[N] = {Protected}

N /: Default[N, 2] := {MachinePrecision, MachinePrecision}
```

```
PrimeQ[157]
EvenQ[5]
OddQ[7]
IntegerQ[2.1]
```

```
True

False

True

False
```

```
PrimeQ[2^100 - 5]
EvenQ[13]
```

```
False

False
```

```
2^9942 - 1;
PrimeQ[2^9941 - 1]
```

```
True
```

b = 4; c = $\frac{5}{4}$;
c + b
N[%]

$\frac{21}{4}$

```
5.25
```

```
Clear[c, b]
c
b
```

```
c

b
```

```
c = 9; b = 2;
c + b
b^2 + c^3
```

```
11
```

```
733
```

```
?? Clear
```

Clear[$symbol_1$, $symbol_2$, …] clears values and definitions for the $symbol_i$.
Clear["$form_1$", "$form_2$", …] clears values and definitions for all symbols whose names match any of the string patterns $form_i$. >>

```
Attributes[Clear] = {HoldAll, Protected}
```

```
5 !
```

```
120
```

```
24. / 17
```

```
1.41176
```

```
40 !
```

```
815 915 283 247 897 734 345 611 269 596 115 894 272 000 000 000
```

```
?? FactorInteger
```

FactorInteger[n] gives a list of the prime factors of the integer n, together with their exponents.
FactorInteger[n, k] does partial factorization, pulling out at most k distinct factors. >>

```
Attributes[FactorInteger] = {Listable, Protected}
```

```
Options[FactorInteger] = {GaussianIntegers → False}
```

```
FactorInteger[122 255]
5 × 7^2 × 499
```

```
{{5, 1}, {7, 2}, {499, 1}}
```

```
122 255
```

```
(**********************************************************)
a = Tan[3 Pi / 11] + 4 Sin[2 Pi / 11]
```

$\text{Cot}\left[\frac{5\pi}{22}\right] + 4\,\text{Sin}\left[\frac{2\pi}{11}\right]$

```
y1 = (x1 + 1) / (1 - x1^2);
FullSimplify[y1]
Simplify[a];
FullSimplify[a];
N[a]
```

$$\frac{1}{1 - x1}$$

3.31662

```
(*******************************************************)
```

```
?? Sqrt
```

Sqrt[*z*] or $\sqrt{z}$ gives the square root of *z*. >>

Attributes[Sqrt] = {Listable, NumericFunction, Protected}

```
?? EngineeringForm
```

EngineeringForm[*expr*] prints with all real numbers in *expr* given in engineering notation.
EngineeringForm[*expr*, *n*] prints with numbers given to *n*-digit precision. >>

```
EngineeringForm[{123 450 000.0, 0.00012345, 123.45}]
EngineeringForm[123.45]
```

$\{123.45 \times 10^{6}, 123.45 \times 10^{-6}, 123.45\}$

123.45

```
x = 3
Clear[x]
```

3

```
Clear[x]
Expand[(1 + x)^10]
```

$1 + 10 x + 45 x^2 + 120 x^3 + 210 x^4 + 252 x^5 + 210 x^6 + 120 x^7 + 45 x^8 + 10 x^9 + x^{10}$

Factor$[1 + 10 x + 45 x^2 + 120 x^3 + 210 x^4 + 252 x^5 + 210 x^6 + 120 x^7 + 45 x^8 + 10 x^9 + x^{10}]$

$(1 + x)^{10}$

```
Factor[(n + 1) (n + 2) (n + 3) (n + 4) + 1]
```

Expand$[(5 + 5 n + n^2)^2]$

```
a1 = Cos[x]^2 + Sin[x]^2 // Simplify
Simplify[%]
a2 = 1 - Cos[2 x]
Simplify[%]
Simplify[a2];
```

```
1
```

```
1
```

```
1 - Cos[2 x]
```

$2\,\mathrm{Sin}[x]^2$

```
?? TrigExpand
```

TrigExpand[*expr*] expands out trigonometric functions in *expr*. >>

```
Attributes[TrigExpand] = {Protected}
```

$$\sin^3(x)\cos^3(x) = \frac{3\sin(2x) - \sin(6x)}{32}$$

$$\frac{1+\sin(x)-\cos(x)}{1+\sin(x)+\cos(x)} = \tan(x/2)$$

```
Sin[x + y] == Cos[y] Sin[x] + Cos[x] Sin[y]
```

```
Sin[x + y] == Cos[y] Sin[x] + Cos[x] Sin[y]
```

```
TrigExpand[Sin[x + y2]]
```

```
Cos[y2] Sin[x] + Cos[x] Sin[y2]
```

```
TrigExpand[Sin[x]^3 Cos[x]^3]
```

$\mathrm{Cos}[x]^3\,\mathrm{Sin}[x]^3$

```
Simplify[Sin[x]^3 Cos[x]^3 == (3 Sin[2 x] - Sin[6 x]) / 32]
```

```
True
```

x^2

x^2

$\sqrt{25}$

5

```
?? Log
```

Log[*z*] gives the natural logarithm of *z* (logarithm to base *e*).
Log[*b*, *z*] gives the logarithm to base *b*. >>

```
Attributes[Log] = {Listable, NumericFunction, Protected}
```

HomeWork problems 1.2, 1.4, 1.5, 1.7, 1.8