

Oct 03, 10 22:57

stdin

Page 1/16

Maxima 5.19.2 <http://maxima.sourceforge.net>

Using Lisp SBCL 1.0.29

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Dedicated to the memory of William Schelter.

The function bug_report() provides bug reporting information.

(%i1) batch(answers01.max)

batching /Users/uberphysicist/Documents/Teaching/MA4005_Engineering_Maths_T1/tutorials/answers01.max

(%i2) *****

(%i3) Q1

(%i4) *****

(%i5) ***** i *****
2 2

(%i6) f : y + x

(%i7) Diff(f, x) = diff(f, x)

(%o7) Diff(f, x) = 2 x

(%i8) Diff(f, y) = diff(f, y)

(%o8) Diff(f, y) = 2 y

(%i9) ***** ii *****
3 5

(%i10) f : x y

(%i11) Diff(f, x) = diff(f, x)
2 5

(%o11) Diff(f, x) = 3 x y

(%i12) Diff(f, y) = diff(f, y)
3 4

(%o12) Diff(f, y) = 5 x y

(%i13) ***** iii *****

(%i14) f : (2 x y² - 4 y) exp(x)

Oct 03, 10 22:57

stdin

Page 2/16

```
(%i15)          Diff(f, x) = diff(f, x)
                x          2          x  2
(%o15)          Diff(f, x) = %e (2 x y  - 4 y) + 2 %e y
(%i16)          Diff(f, y) = diff(f, y)
                x
(%o16)          Diff(f, y) = %e (4 x y - 4)
(%i17)          ***** iv *****
(%i18)          f : sin(5 y + 2 x)
(%i19)          Diff(f, x) = diff(f, x)
(%o19)          Diff(f, x) = 2 cos(5 y + 2 x)
(%i20)          Diff(f, y) = diff(f, y)
(%o20)          Diff(f, y) = 5 cos(5 y + 2 x)
(%i21)          ***** v *****
                3
(%i22)          f : 5 x y  cos(y + x)
(%i23)          Diff(f, x) = diff(f, x)
                3          3
(%o23)          Diff(f, x) = 5 y  cos(y + x) - 5 x y  sin(y + x)
(%i24)          Diff(f, y) = diff(f, y)
                2          3
(%o24)          Diff(f, y) = 15 x y  cos(y + x) - 5 x y  sin(y + x)
(%i25)          ***** vi *****
                x    y
(%i26)          f : -- - --
                2    2
                y    x
(%i27)          Diff(f, x) = diff(f, x)
                2 y    1
(%o27)          Diff(f, x) = --- + --
                3      2
                x    y
(%i28)          Diff(f, y) = diff(f, y)
                2 x    1
```

Oct 03, 10 22:57

stdin

Page 3/16

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(%o28)          Diff(f, y) = - ---- - --
                      3      2
                      y      x
(%i29)          ***** vii *****
                      2
(%i30)          f : log(y + x )
(%i31)          Diff(f, x) = diff(f, x)
                      2 x
(%o31)          Diff(f, x) = -----
                      2
                      y + x
(%i32)          Diff(f, y) = diff(f, y)
                      1
(%o32)          Diff(f, y) = -----
                      2
                      y + x
(%i33)          ***** viii *****
(%i34)          f : z x + y z + x y
(%i35)          Diff(f, x) = diff(f, x)
(%o35)          Diff(f, x) = z + y
(%i36)          Diff(f, y) = diff(f, y)
(%o36)          Diff(f, y) = z + x
(%i37)          Diff(f, z) = diff(f, z)
(%o37)          Diff(f, z) = y + x
(%i38)          ***** ix *****
                      2
                      w
(%i39)          f : -----
                      2 3
                      x y z
(%i40)          Diff(f, x) = diff(f, x)
                      2
                      w

```

(%o40)
$$\text{Diff}(f, x) = - \frac{x^2 y^2 z^3}{2}$$

(%i41)
$$\text{Diff}(f, y) = \text{diff}(f, y)$$

(%o41)
$$\text{Diff}(f, y) = - \frac{2 w}{3}$$

(%i42)
$$\text{Diff}(f, z) = \text{diff}(f, z)$$

(%o42)
$$\text{Diff}(f, z) = - \frac{3 w}{2}$$

(%i43)
$$\text{Diff}(f, w) = \text{diff}(f, w)$$

(%o43)
$$\text{Diff}(f, w) = \frac{2 w}{x y z}$$

(%i44) *****

(%i45) Q2

(%i46) *****

(%i47) ***** i *****
2 2

(%i48) f : y + x

(%i49)
$$\text{Diff}(f, x, 2) = \text{diff}(f, x, 2)$$

(%o49)
$$\text{Diff}(f, x, 2) = 2$$

(%i50)
$$\text{Diff}(f, y, 2) = \text{diff}(f, y, 2)$$

(%o50)
$$\text{Diff}(f, y, 2) = 2$$

(%i51)
$$\text{Diff}(f, x, 1, y, 1) = \text{diff}(f, x, 1, y, 1)$$

Oct 03, 10 22:57

stdin

Page 5/16

```

(%o51)          Diff(f, x, 1, y, 1) = 0
(%i52)          ***** ii *****
                3 5
(%i53)          f : x y
(%i54)          Diff(f, x, 2) = diff(f, x, 2)
                5
(%o54)          Diff(f, x, 2) = 6 x y
(%i55)          Diff(f, y, 2) = diff(f, y, 2)
                3 3
(%o55)          Diff(f, y, 2) = 20 x y
(%i56)          Diff(f, x, 1, y, 1) = diff(f, x, 1, y, 1)
                2 4
(%o56)          Diff(f, x, 1, y, 1) = 15 x y
(%i57)          ***** iii *****
                2
(%i58)          f : (2 x y - 4 y) exp(x)
(%i59)          Diff(f, x, 2) = diff(f, x, 2)
                x      2      x 2
(%o59)          Diff(f, x, 2) = %e (2 x y - 4 y) + 4 %e y
(%i60)          Diff(f, y, 2) = diff(f, y, 2)
                x
(%o60)          Diff(f, y, 2) = 4 x %e
(%i61)          Diff(f, x, 1, y, 1) = diff(f, x, 1, y, 1)
                x      x
(%o61)          Diff(f, x, 1, y, 1) = %e (4 x y - 4) + 4 %e y
(%i62)          ***** iv *****
(%i63)          f : sin(5 y + 2 x)
(%i64)          Diff(f, x, 2) = diff(f, x, 2)
(%o64)          Diff(f, x, 2) = - 4 sin(5 y + 2 x)
(%i65)          Diff(f, y, 2) = diff(f, y, 2)
(%o65)          Diff(f, y, 2) = - 25 sin(5 y + 2 x)
(%i66)          Diff(f, x, 1, y, 1) = diff(f, x, 1, y, 1)
(%o66)          Diff(f, x, 1, y, 1) = - 10 sin(5 y + 2 x)

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Oct 03, 10 22:57

stdin

Page 6/16

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(%i67)          ***** v *****
                3
(%i68)          f : 5 x y  cos(y + x)
(%i69)          Diff(f, x, 2) = diff(f, x, 2)
                3                3
(%o69)          Diff(f, x, 2) = - 10 y  sin(y + x) - 5 x y  cos(y + x)
(%i70)          Diff(f, y, 2) = diff(f, y, 2)
                2                3
(%o70)          Diff(f, y, 2) = - 30 x y  sin(y + x) - 5 x y  cos(y + x)
                                     + 30 x y cos(y + x)
(%i71)          Diff(f, x, 1, y, 1) = diff(f, x, 1, y, 1)
                3                2
(%o71)          Diff(f, x, 1, y, 1) = - 5 y  sin(y + x) - 15 x y  sin(y + x)
                                     - 5 x y  cos(y + x) + 15 y  cos(y + x)
(%i72)          ***** vi *****
                x    y
(%i73)          f : -- - --
                2    2
                y    x
(%i74)          Diff(f, x, 2) = diff(f, x, 2)
                6 y
(%o74)          Diff(f, x, 2) = - ----
                4
                x
(%i75)          Diff(f, y, 2) = diff(f, y, 2)
                6 x
(%o75)          Diff(f, y, 2) = ----
                4
                y
(%i76)          Diff(f, x, 1, y, 1) = diff(f, x, 1, y, 1)
                2    2
(%o76)          Diff(f, x, 1, y, 1) = -- - --

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Oct 03, 10 22:57

stdin

Page 7/16

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                                3      3
                                x      y
(%i77)      ***** vii *****
                                2
(%i78)      f : log(y + x )
(%i79)      Diff(f, x, 2) = diff(f, x, 2)
                                2
                                2      4 x
(%o79)      Diff(f, x, 2) = ----- - -----
                                2      2 2
                                y + x      (y + x )
(%i80)      Diff(f, y, 2) = diff(f, y, 2)
                                1
(%o80)      Diff(f, y, 2) = - -----
                                2 2
                                (y + x )
(%i81)      Diff(f, x, 1, y, 1) = diff(f, x, 1, y, 1)
                                2 x
(%o81)      Diff(f, x, 1, y, 1) = - -----
                                2 2
                                (y + x )
(%i82)      ***** viii *****
(%i83)      f : z x + y z + x y
(%i84)      Diff(f, x, 2) = diff(f, x, 2)
(%o84)      Diff(f, x, 2) = 0
(%i85)      Diff(f, y, 2) = diff(f, y, 2)
(%o85)      Diff(f, y, 2) = 0
(%i86)      Diff(f, z, 2) = diff(f, z, 2)
(%o86)      Diff(f, z, 2) = 0
(%i87)      Diff(f, x, 1, y, 1) = diff(f, x, 1, y, 1)
(%o87)      Diff(f, x, 1, y, 1) = 1
(%i88)      Diff(f, y, 1, z, 1) = diff(f, y, 1, z, 1)
(%o88)      Diff(f, y, 1, z, 1) = 1

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Oct 03, 10 22:57

stdin

Page 8/16

```

(%i89)      Diff(f, z, 1, x, 1) = diff(f, z, 1, x, 1)
(%o89)      Diff(f, z, 1, x, 1) = 1
(%i90)      ***** ix *****
              2
              w
(%i91)      f : -----
              2 3
              x y z
(%i92)      Diff(f, x, 2) = diff(f, x, 2)
              2
              2 w
(%o92)      Diff(f, x, 2) = -----
              3 2 3
              x y z
(%i93)      Diff(f, y, 2) = diff(f, y, 2)
              2
              6 w
(%o93)      Diff(f, y, 2) = -----
              4 3
              x y z
(%i94)      Diff(f, z, 2) = diff(f, z, 2)
              2
              12 w
(%o94)      Diff(f, z, 2) = -----
              2 5
              x y z
(%i95)      Diff(f, w, 2) = diff(f, w, 2)
              2
(%o95)      Diff(f, w, 2) = -----
              2 3
              x y z
(%i96)      Diff(f, x, 1, y, 1) = diff(f, x, 1, y, 1)
              2

```



```
(%o96)          Diff(f, x, 1, y, 1) =  $\frac{2 w^2}{x^2 y^2 z^3}$ 
(%i97)          Diff(f, x, 1, z, 1) = diff(f, x, 1, z, 1)
(%o97)          Diff(f, x, 1, z, 1) =  $\frac{3 w^3}{x^2 y^2 z^4}$ 
(%i98)          Diff(f, x, 1, w, 1) = diff(f, x, 1, w, 1)
(%o98)          Diff(f, x, 1, w, 1) =  $-\frac{2 w^2}{x^2 y^2 z^3}$ 
(%i99)          Diff(f, y, 1, z, 1) = diff(f, y, 1, z, 1)
(%o99)          Diff(f, y, 1, z, 1) =  $\frac{6 w^6}{x^3 y^4 z^2}$ 
(%i100)         Diff(f, z, 1, w, 1) = diff(f, z, 1, w, 1)
(%o100)         Diff(f, z, 1, w, 1) =  $-\frac{6 w^6}{x^2 y^4 z}$ 
```

```
(%i101)
*****
(%i102)          Q3
(%i103)
*****
```

$\frac{2}{(\pi D)^2} H$

Oct 03, 10 22:57

stdin

Page 10/16

```
(%i104)          V : -----
                    4
(%i105)          dV_max : abs(dVdH) dH + abs(dVdD) dD
(%i106)          dVdD : diff(V, D)
                    pi D H
(%o106)          -----
                    2
(%i107)          dVdH : diff(V, H)
                    2
                    pi D
(%o107)          -----
                    4
(%i108) aaa01 : [D = 6 inch, H = 4 inch, dD = 0.05 inch, dH = 0.01 inch,
                    pi = %pi]
(%o108) [D = 6 inch, H = 4 inch, dD = 0.05 inch, dH = 0.01 inch, pi = %pi]
(%i109)          dV_max : ev(dV_max, aaa01, infeval)
                    3
(%o109)          .690000000000000001 %pi inch
(%i110)          float(dV_max)
                    3
(%o110)          2.167698930976957 inch
(%i111)
*****
(%i112)          Q4
(%i113)
*****
                    2
                    K B D
(%i114)          W : -----
                    L
                    2
                    B D K
(%o114)          -----
```

```
(%i115) eq01 : 0 = diff(W, L) dL + diff(W, D) dD + diff(W, B) dB
```

```
(%o115) 0 = 
$$\frac{2 B D dD K}{L} + \frac{D dB K}{L} - \frac{B D dL K}{L^2}$$

```

```
(%i116) aaa01 : solve(eq01, dD)
```

```
(%o116) [dD = - 
$$\frac{D dB L - B D dL}{2 B L}$$
]
```

```
(%i117) aaa01 : expand(-----)
```

```
(%o117) [-- = 
$$\frac{dD}{D} - \frac{dL}{2 L} - \frac{dB}{2 B}$$
]
```

```
(%i118) aaa01 : ev(aaa01, dL = 1 L pc, dB = 5 B pc)
```

```
(%o118) [-- = 
$$-\frac{dD}{D} - 2 \text{ pc}$$
]
```

```
(%i119) float(aaa01)
```

```
(%o119) [-- = 
$$-\frac{dD}{D} - 2.0 \text{ pc}$$
]
```

```
(%i120) *****
```

```
(%i121) Q5
```

```
(%i122) *****
```

```
(%i123) assume(cm > 0, s > 0)
```

```
(%i124) a : sqrt(- 2 b c cos(A) + c2 + b2)
```

```

(%o124)          2      2
              sqrt(- 2 b c cos(A) + c  + b )
(%i125) a_dot : diff(a, A) A_dot + diff(a, c) c_dot + diff(a, b) b_dot
              A_dot b c sin(A)          b_dot (2 b - 2 c cos(A))
(%o125) ----- + -----
              2      2          2      2
              sqrt(- 2 b c cos(A) + c  + b )    2 sqrt(- 2 b c cos(A) + c  + b )
              c_dot (2 c - 2 b cos(A))
              + -----
              2      2
              2 sqrt(- 2 b c cos(A) + c  + b )
(%i126) aaa01 : [b = 16 cm, c = 10 cm, A = -----, b_dot = -----,
              180          s
              9 pi
              -----
              - 1 cm          180
              c_dot = -----, A_dot = -----, pi = %pi]
              s          s
(%i127)          a_dot : ev(a_dot, aaa01, infeval)
              2 sqrt(3) %pi cm    9 cm
(%o127)          ----- + -----
              7 s          14 s
(%i128)          a_dot = float(a_dot)
              2.197542312200758 cm
(%o128)          a_dot = -----
              s
              b c sin(A)
(%i129)          area : -----
              2
              b c sin(A)
(%o129)          -----
              2

```

Oct 03, 10 22:57

stdin

Page 13/16

```
(%i130) area_dot : diff(area, A) A_dot + diff(area, c) c_dot
                    + diff(area, b) b_dot
                    b c_dot sin(A)  b_dot c sin(A)  A_dot b c cos(A)
(%o130)  ----- + ----- + -----
                    2                2                2
(%i131)  area_dot : ev(area_dot, aaa01, infeval)
                    2  3/2  2
                    2 %pi cm  3  cm
(%o131)  ----- - -----
                    s          2 s
(%i132)  area_dot = float(area_dot)
                    2
                    3.685109095826271 cm
(%o132)  area_dot = -----
                    s
(%i133)  *****
(%i134)  Q6
(%i135)  *****
                    2
(%i136)  V : pi r h
                    2
                    h pi r
(%o136)  h pi r
(%i137)  V_dot : diff(V, h) h_dot + diff(V, r) r_dot
                    2
                    2 h pi r r_dot + h_dot pi r
(%o137)  2 cm  3 cm
(%i138)  aaa01 : [r_dot = ----, h_dot = ----, r = 10 cm, h = 20 cm, pi = %pi]
                    s          s
(%o138)  [r_dot = ----, h_dot = ----, r = 10 cm, h = 20 cm, pi = %pi]
                    s          s
```

Oct 03, 10 22:57

stdin

Page 14/16

```

(%i139)          V_dot : ev(V_dot, aaa01, infeval)
                    3
                    1100 %pi cm
(%o139)          -----
                    s
(%i140)          V_dot = float(V_dot)
                    3
                    3455.751918948773 cm
(%o140)          V_dot = -----
                    s
(%i141)
*****
(%i142)          Q7
(%i143)          kill(all)
(%o0)           done
(%i1)
*****
(%i2)          ***** a *****
(%i3)          f : y exp(3 x y) cos(x y)
                    3 x y
(%o3)          y %e      cos(x y)
(%i4)          diff(f, x, 2)
                    3      3 x y      3      3 x y
(%o4)          8 y %e      cos(x y) - 6 y %e      sin(x y)
(%i5)          ratsimp(diff(f, y, 2))
                    2      3 x y      2      3 x y
(%o5)          (- 6 x y - 2 x) %e      sin(x y) + (8 x y + 6 x) %e      cos(x y)
(%i6)          ratsimp(diff(f, x, 1, y, 1))
                    2      3 x y      2      3 x y
(%o6)          (- 6 x y - 2 y) %e      sin(x y) + (8 x y + 6 y) %e      cos(x y)
(%i7)          g : -----
                    2

```

```

(%o7)
      x  - 2 y
      2 x - 3 y
      -----
              2
              x  - 2 y
(%i8)  factor(ratsimp(diff(g, x, 2)))
              2      2      3
2 (6 y  + 9 x  y - 12 x y - 2 x )
-----
              2 3
      (2 y - x )
(%i9)  factor(ratsimp(xthru(diff(g, y, 2))))
              4 x (3 x - 4)
(%o9)  -----
              2 3
      (2 y - x )
(%i10)  factor(ratsimp(diff(g, x, 1, y, 1)))
              3      2
2 (6 x y - 4 y + 3 x  - 6 x )
(%o10)  -----
              2 3
      (2 y - x )
(%i11)  ***** b *****
(%i12)  ***** i *****
              n R T
(%i13)  P : -----
              V
              n R T
(%o13)  -----
              V
(%i14)  dP : diff(P, V) dV + diff(P, T) dT + diff(P, n) dn
              dn R T   n dT R   n dV R T
(%o14)  ----- + ----- - -----

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Oct 03, 10 22:57

stdin

Page 16/16

```

          V      V      2
          V      V
(%i15)          ***** ii *****
(%i16) P : ev(dP, n = n0, T = T0, V = V0, dV = - deltaV, dT = deltaT, dn = 0)
                                                    + P0

(%o16)          n0 deltaT R      n0 deltaV R T0
          ----- + ----- + P0
          V0                    2
          V0

(%o16) /Users/uberphysicist/Documents/Teaching/MA4005_Engineering_Maths_T1/tut\
orials/answers01.max

```