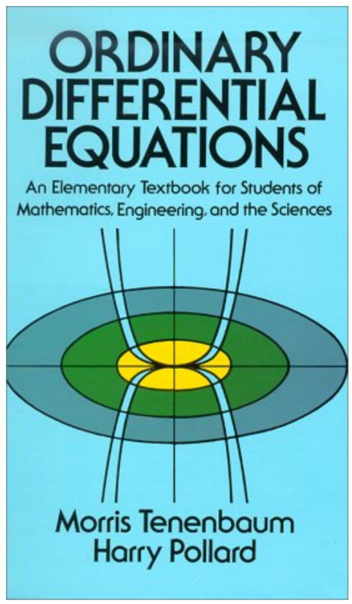
A Solution Manual For

Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963



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Contents

1 Chapter 2. Special types of differential equations of the first kind. Lesson 7

1.1 problem First order with homogeneous Coefficients. Exercise 7.2, page 61

Internal problem ID [3918]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 7
Problem number: First order with homogeneous Coefficients. Exercise 7.2, page 61.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, 'class A'], _exact, _rational, _dAlembert]`

$$\boxed{2xy + \left(y^2 + x^2\right) y' = 0}$$

✓ Solution by Maple

Time used: 0.031 (sec). Leaf size: 257

```
dsolve(2*x*y(x)+(x^2+y(x)^2)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{\frac{\left(4+4\sqrt{4x^6c_1^3+1}\right)^{\frac{1}{3}}}{2} - \frac{2x^2c_1}{\left(4+4\sqrt{4x^6c_1^3+1}\right)^{\frac{1}{3}}}}{\sqrt{c_1}}$$

$$y(x) = \frac{-\frac{\left(4+4\sqrt{4x^6c_1^3+1}\right)^{\frac{1}{3}}}{4} + \frac{x^2c_1}{\left(4+4\sqrt{4x^6c_1^3+1}\right)^{\frac{1}{3}}} - \frac{i\sqrt{3}\left(\frac{\left(4+4\sqrt{4x^6c_1^3+1}\right)^{\frac{1}{3}}}{2} + \frac{2x^2c_1}{\left(4+4\sqrt{4x^6c_1^3+1}\right)^{\frac{1}{3}}}\right)}{2}}{\sqrt{c_1}}$$

$$y(x) = \frac{-\frac{\left(4+4\sqrt{4x^6c_1^3+1}\right)^{\frac{1}{3}}}{4} + \frac{x^2c_1}{\left(4+4\sqrt{4x^6c_1^3+1}\right)^{\frac{1}{3}}} + \frac{i\sqrt{3}\left(\frac{\left(4+4\sqrt{4x^6c_1^3+1}\right)^{\frac{1}{3}}}{2} + \frac{2x^2c_1}{\left(4+4\sqrt{4x^6c_1^3+1}\right)^{\frac{1}{3}}}\right)}{2}}{\sqrt{c_1}}$$

✓ Solution by Mathematica

Time used: 15.691 (sec). Leaf size: 362

```
DSolve[2*x*y[x]+(x^2+y[x]^2)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{\sqrt[3]{\sqrt{4x^6+e^{6c_1}}+e^{3c_1}}}{\sqrt[3]{2}} - \frac{\sqrt[3]{2}x^2}{\sqrt[3]{\sqrt{4x^6+e^{6c_1}}+e^{3c_1}}}$$

$$y(x) \to \frac{2\sqrt[3]{-2}x^2 + (-2)^{2/3}\left(\sqrt{4x^6+e^{6c_1}}+e^{3c_1}\right)^{2/3}}{2\sqrt[3]{\sqrt{4x^6+e^{6c_1}}+e^{3c_1}}}$$

$$y(x) \to -\frac{2(-1)^{2/3}x^2 + \sqrt[3]{-2}\left(\sqrt{4x^6+e^{6c_1}}+e^{3c_1}\right)^{2/3}}{2^{2/3}\sqrt[3]{\sqrt{4x^6+e^{6c_1}}+e^{3c_1}}}$$

$$y(x) \to 0$$

$$y(x) \to \frac{1}{2}\sqrt[6]{x^6}\left(\frac{\left(1-i\sqrt{3}\right)\left(x^6\right)^{2/3}}{x^4} - i\sqrt{3} - 1\right)$$

$$y(x) \to \frac{1}{2}\sqrt[6]{x^6}\left(\frac{\left(1+i\sqrt{3}\right)\left(x^6\right)^{2/3}}{x^4} + i\sqrt{3} - 1\right)$$

$$y(x) \to \sqrt[6]{x^6} - \frac{\left(x^6\right)^{5/6}}{x^4}$$

1.2 problem First order with homogeneous Coefficients. Exercise 7.3, page 61

Internal problem ID [3919]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 7
Problem number: First order with homogeneous Coefficients. Exercise 7.3, page 61.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class A‘], _rational, _dAlembert]`

$$\boxed{\left(x+\sqrt{y^2-xy}\right)y'-y=0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 27

```
dsolve((x+sqrt(y(x)^2-x*y(x)))*diff(y(x),x)-y(x)=0,y(x), singsol=all)
```

$$\ln\left(y(x)\right)+\frac{2\sqrt{y\left(x\right)\left(y\left(x\right)-x\right)}}{y\left(x\right)}-c_1=0$$

✓ Solution by Mathematica

Time used: 0.301 (sec). Leaf size: 43

```
DSolve[(x+Sqrt[y[x]^2-x*y[x]])*y'[x]-y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$\text{Solve}\left[\frac{2\sqrt{\frac{y(x)}{x}-1}}{\sqrt{\frac{y(x)}{x}}}+\log\left(\frac{y(x)}{x}\right)=-\log(x)+c_1,y(x)\right]$$

1.3 problem First order with homogeneous Coefficients. Exercise 7.4, page 61

Internal problem ID [3920]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 7
Problem number: First order with homogeneous Coefficients. Exercise 7.4, page 61.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class A‘], _rational, [_Abel, ‘2nd type‘, ‘cla`

$$\boxed{x + y - (-y + x)\, y' = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 24

```
dsolve((x+y(x))-(x-y(x))*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \tan\left(\operatorname{RootOf}\left(-2\_Z + \ln\left(\frac{1}{\cos(\_Z)^2}\right) + 2\ln(x) + 2c_1\right)\right) x$$

✓ Solution by Mathematica

Time used: 0.033 (sec). Leaf size: 36

```
DSolve[(x+y[x])-(x-y[x])*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$\text{Solve}\left[\frac{1}{2}\log\left(\frac{y(x)^2}{x^2} + 1\right) - \arctan\left(\frac{y(x)}{x}\right) = -\log(x) + c_1, y(x)\right]$$

1.4 problem First order with homogeneous Coefficients. Exercise 7.5, page 61

Internal problem ID [3921]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 7
Problem number: First order with homogeneous Coefficients. Exercise 7.5, page 61.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class A‘], _dAlembert]`

$$\boxed{y'x - y - x\sin\left(\frac{y}{x}\right) = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 44

```
dsolve(x*diff(y(x),x)-y(x)-x*sin(y(x)/x)=0,y(x), singsol=all)
```

$$y(x) = \arctan\left(\frac{2xc_1}{c_1^2x^2+1}, -\frac{c_1^2x^2-1}{c_1^2x^2+1}\right)x$$

✓ Solution by Mathematica

Time used: 2.772 (sec). Leaf size: 33

```
DSolve[x*y'[x]-y[x]-x*Sin[y[x]/x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to 2x\arctan\left(e^{c_1}x\right)$$
$$y(x) \to 0$$
$$y(x) \to \pi\sqrt{x^2}$$

1.5 problem First order with homogeneous Coefficients. Exercise 7.6, page 61

Internal problem ID [3922]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 7
Problem number: First order with homogeneous Coefficients. Exercise 7.6, page 61.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class A‘], _rational, _dAlembert]`

$$\boxed{2x^2y + y^3 + (xy^2 - 2x^3)\,y' = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 19

```
dsolve((2*x^2*y(x)+y(x)^3)+(x*y(x)^2-2*x^3)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \sqrt{-\frac{2}{\mathrm{LambertW}\left(-2c_1x^4\right)}}\,x$$

✓ Solution by Mathematica

Time used: 6.133 (sec). Leaf size: 66

```
DSolve[(2*x^2*y[x]+y[x]^3)+(x*y[x]^2-2*x^3)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -\frac{i\sqrt{2}x}{\sqrt{W\left(-2e^{-2c_1}x^4\right)}}$$

$$y(x) \to \frac{i\sqrt{2}x}{\sqrt{W\left(-2e^{-2c_1}x^4\right)}}$$

$$y(x) \to 0$$

1.6 problem First order with homogeneous Coefficients. Exercise 7.7, page 61

Internal problem ID [3923]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 7
Problem number: First order with homogeneous Coefficients. Exercise 7.7, page 61.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class G‘], _dAlembert]`

$$\boxed{y^2 + \left(x\sqrt{y^2 - x^2} - xy\right) y' = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 30

```
dsolve(y(x)^2+(x*sqrt(y(x)^2-x^2)-x*y(x))*diff(y(x),x)=0,y(x), singsol=all)
```

$$\frac{\sqrt{y(x)^2 - x^2}}{x y(x)} + \frac{1}{x} - c_1 = 0$$

✓ Solution by Mathematica

Time used: 2.257 (sec). Leaf size: 111

```
DSolve[y[x]^2+(x*Sqrt[y[x]^2-x^2]-x*y[x])*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$\text{Solve}\left[-\frac{\sqrt{\frac{y(x)^2}{x^2}-1}\left(\log\left(\sqrt{\frac{y(x)}{x}+1}-1\right)+\log\left(\sqrt{\frac{y(x)}{x}+1}+1\right)\right)}{\sqrt{\frac{y(x)}{x}-1}\sqrt{\frac{y(x)}{x}+1}} - 2\log\left(\sqrt{\frac{y(x)}{x}-1}-\sqrt{\frac{y(x)}{x}+1}\right) = \log(x)+c_1, y(x)\right]$$

1.7 problem First order with homogeneous Coefficients. Exercise 7.8, page 61

Internal problem ID [3924]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 7
Problem number: First order with homogeneous Coefficients. Exercise 7.8, page 61.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class A‘], _dAlembert]`

$$\boxed{\frac{y\cos\left(\frac{y}{x}\right)}{x}-\left(\frac{x\sin\left(\frac{y}{x}\right)}{y}+\cos\left(\frac{y}{x}\right)\right)y'=0}$$

✓ Solution by Maple

Time used: 0.047 (sec). Leaf size: 15

```
dsolve(y(x)/x*cos(y(x)/x)-(x/y(x)*sin(y(x)/x)+cos(y(x)/x))*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x)=\operatorname{RootOf}\left(\_Zxc_1\sin\left(\_Z\right)-1\right)x$$

✓ Solution by Mathematica

Time used: 0.267 (sec). Leaf size: 35

```
DSolve[y[x]/x*Cos[y[x]/x]-(x/y[x]*Sin[y[x]/x]+Cos[y[x]/x])*y'[x]==0,y[x],x,IncludeSingularSol
```

$$\text{Solve}\left[\log\left(\frac{y(x)}{x}\right)+\log\left(\tan\left(\frac{y(x)}{x}\right)\right)+\log\left(\cos\left(\frac{y(x)}{x}\right)\right)=-\log(x)+c_1,y(x)\right]$$

1.8 problem First order with homogeneous Coefficients. Exercise 7.9, page 61

Internal problem ID [3925]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 7
Problem number: First order with homogeneous Coefficients. Exercise 7.9, page 61.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class A‘], _dAlembert]`

$$\boxed{y + x \ln\left(\frac{y}{x}\right) y' - 2y'x = 0}$$

✓ Solution by Maple

Time used: 0.031 (sec). Leaf size: 18

```
dsolve(y(x)+x*ln(y(x)/x)*diff(y(x),x)-2*x*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \mathrm{e}^{-\operatorname{LambertW}(-\mathrm{e}x c_1)+1} x$$

✓ Solution by Mathematica

Time used: 5.57 (sec). Leaf size: 35

```
DSolve[y[x]+x*Log[y[x]/x]*y'[x]-2*x*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -e^{c_1} W\left(-e^{1-c_1} x\right)$$
$$y(x) \to 0$$
$$y(x) \to ex$$

1.9 problem First order with homogeneous Coefficients. Exercise 7.10, page 61

Internal problem ID [3926]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 7
Problem number: First order with homogeneous Coefficients. Exercise 7.10, page 61.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class A‘], _dAlembert]`

$$\boxed{2\,\mathrm{e}^{\frac{x}{y}} y+\left(y-2x\,\mathrm{e}^{\frac{x}{y}}\right) y'=0}$$

✓ Solution by Maple

Time used: 0.078 (sec). Leaf size: 23

```
dsolve(2*y(x)*exp(x/y(x))+(y(x)-2*x*exp(x/y(x)))*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x)=\frac{x}{\operatorname{RootOf}\left(\frac{\_Z\,\mathrm{e}^{-2\,\mathrm{e}^{\_Z}}}{c_1}-x\right)}$$

✓ Solution by Mathematica

Time used: 0.254 (sec). Leaf size: 29

```
DSolve[2*y[x]*Exp[x/y[x]]+(y[x]-2*x*Exp[x/y[x]])*y'[x]==0,y[x],x,IncludeSingularSolutions ->
```

$$\text{Solve}\left[-2e^{\frac{x}{y(x)}}-\log\left(\frac{y(x)}{x}\right)=\log(x)+c_1,y(x)\right]$$

1.10 problem First order with homogeneous Coefficients. Exercise 7.11, page 61

Internal problem ID [3927]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 7
Problem number: First order with homogeneous Coefficients. Exercise 7.11, page 61.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class A‘], _dAlembert]`

$$\boxed{x\,\mathrm{e}^{\frac{y}{x}}-y\sin\left(\frac{y}{x}\right)+x\sin\left(\frac{y}{x}\right)y'=0}$$

✓ Solution by Maple

Time used: 0.031 (sec). Leaf size: 63

```
dsolve((x*exp(y(x)/x)-y(x)*sin(y(x)/x))+x*sin(y(x)/x)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x)=\mathrm{RootOf}\left(\mathrm{e}^{2\_Z}\left(4\ln(x)^2\,\mathrm{e}^{2\_Z}+8\ln(x)\,\mathrm{e}^{2\_Z}c_1+4c_1^2\mathrm{e}^{2\_Z}-4\ln(x)\sin(\_Z)\,\mathrm{e}^{\_Z}-4\sin(\_Z)\,\mathrm{e}^{\_Z}c_1+2\sin(\_Z)^2-1\right)\right)x$$

✓ Solution by Mathematica

Time used: 0.33 (sec). Leaf size: 39

```
DSolve[(x*Exp[y[x]/x]-y[x]*Sin[y[x]/x])+x*Sin[y[x]/x]*y'[x]==0,y[x],x,IncludeSingularSolution
```

$$\mathrm{Solve}\left[-\frac{1}{2}e^{-\frac{y(x)}{x}}\left(\sin\left(\frac{y(x)}{x}\right)+\cos\left(\frac{y(x)}{x}\right)\right)=-\log(x)+c_1,y(x)\right]$$

1.11 problem First order with homogeneous Coefficients. Exercise 7.12, page 61

Internal problem ID [3928]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 7
Problem number: First order with homogeneous Coefficients. Exercise 7.12, page 61.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, 'class A'], _rational, _Bernoulli]`

$$\boxed{-2xyy' + y^2 + x^2 = 0}$$

With initial conditions

$$[y(-1) = 0]$$

✓ Solution by Maple

Time used: 0.047 (sec). Leaf size: 23

```
dsolve([(x^2+y(x)^2)=2*x*y(x)*diff(y(x),x),y(-1) = 0],y(x), singsol=all)
```

$$y(x) = \sqrt{x(x+1)}$$
$$y(x) = -\sqrt{x(x+1)}$$

✓ Solution by Mathematica

Time used: 0.194 (sec). Leaf size: 36

```
DSolve[{(x^2+y[x]^2)==2*x*y[x]*y'[x],y[-1]==0},y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -\sqrt{x}\sqrt{x+1}$$
$$y(x) \to \sqrt{x}\sqrt{x+1}$$

1.12 problem First order with homogeneous Coefficients. Exercise 7.13, page 61

Internal problem ID [3929]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 7
Problem number: First order with homogeneous Coefficients. Exercise 7.13, page 61.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class A‘], _dAlembert]`

$$\boxed{x\,\mathrm{e}^{\frac{y}{x}}+y-y'x=0}$$

With initial conditions

$$[y(1)=0]$$

✓ Solution by Maple

Time used: 0.031 (sec). Leaf size: 15

```
dsolve([(x*exp(y(x)/x)+y(x))=x*diff(y(x),x),y(1) = 0],y(x), singsol=all)
```

$$y(x)=\ln\left(-\frac{1}{\ln(x)-1}\right)x$$

✓ Solution by Mathematica

Time used: 0.321 (sec). Leaf size: 15

```
DSolve[{(x*Exp[y[x]/x]+y[x])==x*y'[x],y[1]==0},y[x],x,IncludeSingularSolutions -> True]
```

$$y(x)\to -x\log(1-\log(x))$$

1.13 problem First order with homogeneous Coefficients. Exercise 7.14, page 61

Internal problem ID [3930]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 7
Problem number: First order with homogeneous Coefficients. Exercise 7.14, page 61.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class A‘], _dAlembert]`

$$\boxed{y' - \frac{y}{x} + \csc\left(\frac{y}{x}\right) = 0}$$

With initial conditions

$$[y(1) = 0]$$

✓ Solution by Maple

Time used: 0.047 (sec). Leaf size: 16

```
dsolve([diff(y(x),x)-y(x)/x+csc(y(x)/x)=0,y(1) = 0],y(x), singsol=all)
```

$$y(x) = x(1 - 2\_B21) \arccos(\ln(x) + 1)$$

✓ Solution by Mathematica

Time used: 0.399 (sec). Leaf size: 24

```
DSolve[{y'[x]-y[x]/x+Csc[y[x]/x]==0,y[1]==0},y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -x \arccos(\log(x) + 1)$$
$$y(x) \to x \arccos(\log(x) + 1)$$

1.14 problem First order with homogeneous Coefficients. Exercise 7.15, page 61

Internal problem ID [3931]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 7
Problem number: First order with homogeneous Coefficients. Exercise 7.15, page 61.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class A‘], _rational, _Bernoulli]`

$$\boxed{xy - y^2 - x^2y' = 0}$$

With initial conditions

$$[y(1) = 1]$$

✓ Solution by Maple

Time used: 0.015 (sec). Leaf size: 12

```
dsolve([(x*y(x)-y(x)^2)-x^2*diff(y(x),x)=0,y(1) = 1],y(x), singsol=all)
```

$$y(x) = \frac{x}{\ln(x) + 1}$$

✓ Solution by Mathematica

Time used: 0.143 (sec). Leaf size: 13

```
DSolve[{(x*y[x]-y[x]^2)-x^2*y'[x]==0,y[1]==1},y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{x}{\log(x) + 1}$$

2 Chapter 2. Special types of differential equations of the first kind. Lesson 8

2.1 problem Differential equations with Linear Coefficients. Exercise 8.1, page 69

Internal problem ID [3932]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 8
Problem number: Differential equations with Linear Coefficients. Exercise 8.1, page 69.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class C‘], _rational, [_Abel, ‘2nd type‘, ‘cla`

$$\boxed{x + 2y - 4 - (2x - 4y)\, y' = 0}$$

✓ Solution by Maple

Time used: 0.031 (sec). Leaf size: 31

```
dsolve((x+2*y(x)-4)-(2*x-4*y(x))*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = 1 - \frac{\tan\left(\operatorname{RootOf}\left(2\_Z + \ln\left(\frac{1}{\cos(\_Z)^2}\right) + 2\ln(x-2) + 2c_1\right)\right)(x-2)}{2}$$

✓ Solution by Mathematica

Time used: 0.059 (sec). Leaf size: 63

```
DSolve[(x+2*y[x]-4)-(2*x-4*y[x])*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$\text{Solve}\left[2\arctan\left(\frac{-2y(x) - x + 4}{x - 2y(x)}\right) + \log\left(\frac{x^2 + 4y(x)^2 - 8y(x) - 4x + 8}{2(x-2)^2}\right) + 2\log(x-2) + c_1 = 0, y(x)\right]$$

2.2 problem Differential equations with Linear Coefficients. Exercise 8.2, page 69

Internal problem ID [3933]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 8
Problem number: Differential equations with Linear Coefficients. Exercise 8.2, page 69.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class C‘], _rational, [_Abel, ‘2nd type‘, ‘cla`

$$\boxed{3x + 2y + 1 - (3x + 2y - 1)\, y' = 0}$$

✓ Solution by Maple

Time used: 0.015 (sec). Leaf size: 21

```
dsolve((3*x+2*y(x)+1)-(3*x+2*y(x)-1)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = -\frac{3x}{2} - \frac{2\,\mathrm{LambertW}\left(-\frac{\mathrm{e}^{\frac{1}{4}}\mathrm{e}^{-\frac{25x}{4}}c_1}{4}\right)}{5} + \frac{1}{10}$$

✓ Solution by Mathematica

Time used: 5.314 (sec). Leaf size: 43

```
DSolve[(3*x+2*y[x]+1)-(3*x+2*y[x]-1)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{10}\left(-4W\left(-e^{-\frac{25x}{4}-1+c_1}\right) - 15x + 1\right)$$
$$y(x) \to \frac{1}{10} - \frac{3x}{2}$$

2.3 problem Differential equations with Linear Coefficients. Exercise 8.3, page 69

Internal problem ID [3934]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 8
Problem number: Differential equations with Linear Coefficients. Exercise 8.3, page 69.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_quadrature]`

$$\boxed{x + y + 1 + (2x + 2y + 2)\, y' = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 17

```
dsolve((x+y(x)+1)+(2*x+2*y(x)+2)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = -x - 1$$
$$y(x) = -\frac{x}{2} + c_1$$

✓ Solution by Mathematica

Time used: 0.002 (sec). Leaf size: 22

```
DSolve[(x+y[x]+1)+(2*x+2*y[x]+2)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -x - 1$$
$$y(x) \to -\frac{x}{2} + c_1$$

2.4 problem Differential equations with Linear Coefficients. Exercise 8.4, page 69

Internal problem ID [3935]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 8
Problem number: Differential equations with Linear Coefficients. Exercise 8.4, page 69.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class C‘], _rational, [_Abel, ‘2nd type‘, ‘cla`

$$\boxed{x + y - 1 + (2x + 2y - 3)\, y' = 0}$$

✓ Solution by Maple

Time used: 0.015 (sec). Leaf size: 29

```
dsolve((x+y(x)-1)+(2*x+2*y(x)-3)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \mathrm{e}^{-\operatorname{LambertW}\left(2\,\mathrm{e}^{x}\mathrm{e}^{-4}\mathrm{e}^{-c_1}\right)+x-4-c_1} + 2 - x$$

✓ Solution by Mathematica

Time used: 5.111 (sec). Leaf size: 33

```
DSolve[(x+y[x]-1)+(2*x+2*y[x]-3)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{2}\left(W\left(-e^{x-1+c_1}\right) - 2x + 4\right)$$
$$y(x) \to 2 - x$$

2.5 problem Differential equations with Linear Coefficients. Exercise 8.5, page 69

Internal problem ID [3936]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 8
Problem number: Differential equations with Linear Coefficients. Exercise 8.5, page 69.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class C‘], _rational, [_Abel, ‘2nd type‘, ‘cla`

$$\boxed{x + y - 1 - (x - y - 1)\, y' = 0}$$

✓ Solution by Maple

Time used: 0.015 (sec). Leaf size: 29

```
dsolve((x+y(x)-1)-(x-y(x)-1)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = -\tan\left(\text{RootOf}\left(2\_Z + \ln\left(\frac{1}{\cos(\_Z)^2}\right) + 2\ln(x-1) + 2c_1\right)\right)(x-1)$$

✓ Solution by Mathematica

Time used: 0.058 (sec). Leaf size: 48

```
DSolve[(x+y[x]-1)-(x-y[x]-1)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$\text{Solve}\left[2\arctan\left(\frac{y(x)+x-1}{-y(x)+x-1}\right) = \log\left(\frac{1}{2}\left(\frac{y(x)^2}{(x-1)^2}+1\right)\right) + 2\log(x-1) + c_1, y(x)\right]$$

2.6 problem Differential equations with Linear Coefficients. Exercise 8.6, page 69

Internal problem ID [3937]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 8
Problem number: Differential equations with Linear Coefficients. Exercise 8.6, page 69.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class C‘], _rational, [_Abel, ‘2nd type‘, ‘cla`

$$\boxed{x + y + (2x + 2y - 1)\, y' = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 29

```
dsolve((x+y(x))+(2*x+2*y(x)-1)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \mathrm{e}^{-\operatorname{LambertW}\left(2\,\mathrm{e}^{x}\mathrm{e}^{-2}\mathrm{e}^{-c_1}\right)+x-2-c_1} - x + 1$$

✓ Solution by Mathematica

Time used: 1.661 (sec). Leaf size: 33

```
DSolve[(x+y[x])+(2*x+2*y[x]-1)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{2}\left(W\left(-e^{x-1+c_1}\right) - 2x + 2\right)$$

$$y(x) \to 1 - x$$

2.7 problem Differential equations with Linear Coefficients. Exercise 8.7, page 69

Internal problem ID [3938]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 8
Problem number: Differential equations with Linear Coefficients. Exercise 8.7, page 69.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_separable]`

$$\boxed{7y - 3 + (2x + 1)\, y' = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 15

```
dsolve((7*y(x)-3)+(2*x+1)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{3}{7} + \frac{c_1}{(1 + 2x)^{\frac{7}{2}}}$$

✓ Solution by Mathematica

Time used: 0.038 (sec). Leaf size: 28

```
DSolve[(7*y[x]-3)+(2*x+1)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{3}{7} + \frac{c_1}{(2x + 1)^{7/2}}$$

$$y(x) \to \frac{3}{7}$$

2.8 problem Differential equations with Linear Coefficients. Exercise 8.8, page 69

Internal problem ID [3939]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 8
Problem number: Differential equations with Linear Coefficients. Exercise 8.8, page 69.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class C‘], _rational, [_Abel, ‘2nd type‘, ‘cla`

$$\boxed{x + 2y + (3x + 6y + 3)\, y' = 0}$$

✓ Solution by Maple

Time used: 0.015 (sec). Leaf size: 35

```
dsolve((x+2*y(x))+(3*x+6*y(x)+3)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{e^{-\operatorname{LambertW}\left(-\frac{e^{-\frac{x}{6}} e^{-\frac{3}{2}} e^{\frac{c_1}{6}}}{2}\right)-\frac{x}{6}-\frac{3}{2}+\frac{c_1}{6}}}{2} - \frac{3}{2} - \frac{x}{2}$$

✓ Solution by Mathematica

Time used: 5.235 (sec). Leaf size: 43

```
DSolve[(x+2*y[x])+(3*x+6*y[x]+3)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{2}\left(-2W\left(-e^{-\frac{x}{6}-1+c_1}\right) - x - 3\right)$$
$$y(x) \to \frac{1}{2}(-x - 3)$$

2.9 problem Differential equations with Linear Coefficients. Exercise 8.9, page 69

Internal problem ID [3940]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 8
Problem number: Differential equations with Linear Coefficients. Exercise 8.9, page 69.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class C‘], _rational, [_Abel, ‘2nd type‘, ‘cla`

$$\boxed{x + 2y + (y - 1)\, y' = 0}$$

✓ Solution by Maple

Time used: 0.234 (sec). Leaf size: 27

```
dsolve((x+2*y(x))+(y(x)-1)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = 1 - \frac{(2 + x)\,(\mathrm{LambertW}\,(c_1(2 + x)) + 1)}{\mathrm{LambertW}\,(c_1\,(2 + x))}$$

✓ Solution by Mathematica

Time used: 1.176 (sec). Leaf size: 143

```
DSolve[(x+2*y[x])+(y[x]-1)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$\mathrm{Solve}\left[-\frac{(-2)^{2/3}\left(-\left((x+1)\log\left(-\frac{3(-2)^{2/3}(x+2)}{y(x)-1}\right)\right) + x\log\left(\frac{3(-2)^{2/3}(y(x)+x+1)}{y(x)-1}\right) + \log\left(\frac{3(-2)^{2/3}(y(x)+x+1)}{y(x)-1}\right) + y\right.}{9(y(x)+x+1)}\right.$$

2.10 problem Differential equations with Linear Coefficients. Exercise 8.10, page 69

Internal problem ID [3941]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 8
Problem number: Differential equations with Linear Coefficients. Exercise 8.10, page 69.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class C‘], _exact, _rational, [_Abel, ‘2nd typ`

$$\boxed{3x - 2y + 4 - (2x + 7y - 1)\, y' = 0}$$

✓ Solution by Maple

Time used: 0.531 (sec). Leaf size: 38

```
dsolve((3*x-2*y(x)+4)-(2*x+7*y(x)-1)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{11}{25} - \frac{\frac{2(25x+26)c_1}{7} + \frac{\sqrt{25(25x+26)^2 c_1^2+7}}{7}}{25c_1}$$

✓ Solution by Mathematica

Time used: 0.126 (sec). Leaf size: 63

```
DSolve[(3*x-2*y[x]+4)-(2*x+7*y[x]-1)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{7}\left(-2x - \sqrt{x(25x+52) + 1 + 49c_1} + 1\right)$$
$$y(x) \to \frac{1}{7}\left(-2x + \sqrt{x(25x+52) + 1 + 49c_1} + 1\right)$$

2.11 problem Differential equations with Linear Coefficients. Exercise 8.11, page 69

Internal problem ID [3942]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 8
Problem number: Differential equations with Linear Coefficients. Exercise 8.11, page 69.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, 'class C'], _rational, [_Abel, '2nd type', 'cla`

$$\boxed{x + y + (3x + 3y - 4)\, y' = 0}$$

With initial conditions

$$[y(1) = 0]$$

✓ Solution by Maple

Time used: 0.172 (sec). Leaf size: 19

```
dsolve([(x+y(x))+(3*x+3*y(x)-4)*diff(y(x),x)=0,y(1) = 0],y(x), singsol=all)
```

$$y(x) = \frac{2\,\mathrm{LambertW}\left(-1, -\frac{3\,\mathrm{e}^{x-\frac{5}{2}}}{2}\right)}{3} + 2 - x$$

✗ Solution by Mathematica

Time used: 0.0 (sec). Leaf size: 0

```
DSolve[{(x+y[x])+(3*x+3*y[x]-4)*y'[x]==0,y[1]==0},y[x],x,IncludeSingularSolutions -> True]
```

$$\{\}$$

2.12 problem Differential equations with Linear Coefficients. Exercise 8.12, page 69

Internal problem ID [3943]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 8
Problem number: Differential equations with Linear Coefficients. Exercise 8.12, page 69.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, 'class C'], _rational, [_Abel, '2nd type', 'cla`

$$\boxed{3x + 2y + 3 - (x + 2y - 1)\, y' = 0}$$

✓ Solution by Maple

Time used: 0.422 (sec). Leaf size: 46

```
dsolve((3*x+2*y(x)+3)-(x+2*y(x)-1)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{9}{2} - \frac{\mathrm{RootOf}\left((2x+4)^5 c_1\_Z^{25} - 5(2x+4)^5 c_1\_Z^{20} - 2\right)^5 (2x+4)}{4} + \frac{3x}{2}$$

✓ Solution by Mathematica

Time used: 60.093 (sec). Leaf size: 3081

```
DSolve[(3*x+2*y[x]+3)-(x+2*y[x]-1)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

Too large to display

2.13 problem Differential equations with Linear Coefficients. Exercise 8.13, page 69

Internal problem ID [3944]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 8
Problem number: Differential equations with Linear Coefficients. Exercise 8.13, page 69.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class C‘], _rational, [_Abel, ‘2nd type‘, ‘cla`

$$\boxed{y + 7 + (2x + y + 3)\, y' = 0}$$

With initial conditions

$$[y(0) = 1]$$

✓ Solution by Maple

Time used: 0.156 (sec). Leaf size: 87

```
dsolve([(y(x)+7)+(2*x+y(x)+3)*diff(y(x),x)=0,y(0) = 1],y(x), singsol=all)
```

$$y(x) = \left(-x^3 + 6x^2 - 12x + 72 + 8\sqrt{-2x^3 + 12x^2 - 24x + 80}\right)^{\frac{1}{3}} + \frac{(x-2)^2}{\left(-x^3 + 6x^2 - 12x + 72 + 8\sqrt{-2x^3 + 12x^2 - 24x + 80}\right)^{\frac{1}{3}}} - x - 5$$

✓ Solution by Mathematica

Time used: 6.83 (sec). Leaf size: 158

```
DSolve[{(y[x]+7)+(2*x+y[x]+3)*y'[x]==0,y[0]==1},y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{x^2 - \left(\sqrt[3]{8\left(\sqrt{80 - 2x((x-6)x+12)} + 9\right) - x((x-6)x+12)} + 4\right)x + \left(8\left(\sqrt{80 - 2x((x-6)x+12)}\right.\right.}{\sqrt[3]{8\left(\sqrt{80 - 2x((x-6)x+12)} +\right.}}$$

2.14 problem Differential equations with Linear Coefficients. Exercise 8.14, page 69

Internal problem ID [3945]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 8
Problem number: Differential equations with Linear Coefficients. Exercise 8.14, page 69.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class C‘], _rational, [_Abel, ‘2nd type‘, ‘cla`

$$x+y+2-(x-y-4)\,y'=0$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 31

```
dsolve((x+y(x)+2)-(x-y(x)-4)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x)=-3-\tan\left(\operatorname{RootOf}\left(2\_Z+\ln\left(\frac{1}{\cos\left(\_Z\right)^{2}}\right)+2\ln\left(x-1\right)+2c_1\right)\right)(x-1)$$

✓ Solution by Mathematica

Time used: 0.057 (sec). Leaf size: 58

```
DSolve[(x+y[x]+2)-(x-y[x]-4)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$\text{Solve}\left[2\arctan\left(\frac{y(x)+x+2}{y(x)-x+4}\right)+\log\left(\frac{x^2+y(x)^2+6y(x)-2x+10}{2(x-1)^2}\right)+2\log(x-1)+c_1=0,y(x)\right]$$

3 Chapter 2. Special types of differential equations of the first kind. Lesson 9

3.1 problem Exact Differential equations. Exercise 9.4, page 79

Internal problem ID [3946]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 9
Problem number: Exact Differential equations. Exercise 9.4, page 79.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_exact, _rational]`

$$\boxed{3x^2y + 8xy^2 + \left(x^3 + 8x^2y + 12y^2\right) y' = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 597

```
dsolve((3*x^2*y(x)+8*x*y(x)^2)+(x^3+8*x^2*y(x)+12*y(x)^2)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{\left(9x^5 - 27c_1 - 8x^6 + 3\sqrt{-3x^{10} + 3x^9 + 48c_1x^6 - 54c_1x^5 + 81c_1^2}\right)^{\frac{1}{3}}}{6} - \frac{6\left(\frac{1}{12}x^3 - \frac{1}{9}x^4\right)}{\left(9x^5 - 27c_1 - 8x^6 + 3\sqrt{-3x^{10} + 3x^9 + 48c_1x^6 - 54c_1x^5 + 81c_1^2}\right)^{\frac{1}{3}}} - \frac{x^2}{3}$$

$$y(x) = -\frac{\left(9x^5 - 27c_1 - 8x^6 + 3\sqrt{-3x^{10} + 3x^9 + 48c_1x^6 - 54c_1x^5 + 81c_1^2}\right)^{\frac{1}{3}}}{12} + \frac{\frac{1}{4}x^3 - \frac{1}{3}x^4}{\left(9x^5 - 27c_1 - 8x^6 + 3\sqrt{-3x^{10} + 3x^9 + 48c_1x^6 - 54c_1x^5 + 81c_1^2}\right)^{\frac{1}{3}}} - \frac{x^2}{3} - \frac{i\sqrt{3}\left(\frac{\left(9x^5-27c_1-8x^6+3\sqrt{-3x^{10}+3x^9+48c_1x^6-54c_1x^5+81c_1^2}\right)^{\frac{1}{3}}}{6} + \frac{\frac{1}{2}x^3-\frac{2}{3}x^4}{\left(9x^5-27c_1-8x^6+3\sqrt{-3x^{10}+3x^9+48c_1x^6-54c_1x^5+81c_1^2}\right)^{\frac{1}{3}}}\right)}{2}$$

$$y(x) = -\frac{\left(9x^5 - 27c_1 - 8x^6 + 3\sqrt{-3x^{10} + 3x^9 + 48c_1x^6 - 54c_1x^5 + 81c_1^2}\right)^{\frac{1}{3}}}{12} + \frac{\frac{1}{4}x^3 - \frac{1}{3}x^4}{\left(9x^5 - 27c_1 - 8x^6 + 3\sqrt{-3x^{10} + 3x^9 + 48c_1x^6 - 54c_1x^5 + 81c_1^2}\right)^{\frac{1}{3}}} - \frac{x^2}{3} + \frac{i\sqrt{3}\left(\frac{\left(9x^5-27c_1-8x^6+3\sqrt{-3x^{10}+3x^9+48c_1x^6-54c_1x^5+81c_1^2}\right)^{\frac{1}{3}}}{6} + \frac{\frac{1}{2}x^3-\frac{2}{3}x^4}{\left(9x^5-27c_1-8x^6+3\sqrt{-3x^{10}+3x^9+48c_1x^6-54c_1x^5+81c_1^2}\right)^{\frac{1}{3}}}\right)}{2}$$

✓ Solution by Mathematica

Time used: 1.708 (sec). Leaf size: 431

```
DSolve[(3*x^2*y[x]+8*x*y[x]^2)+(x^3+8*x^2*y[x]+12*y[x]^2)*y'[x]==0,y[x],x,IncludeSingularSolu
```

$$y(x) \to \frac{1}{6}\left(-2x^2 + \sqrt[3]{(9-8x)x^5 + 3\left(\sqrt{-3(x-1)x^9 + 6c_1(9-8x)x^5 + 81{c_1}^2} + 9c_1\right)} + \frac{(4x-3)x^3}{\sqrt[3]{(9-8x)x^5 + 3\left(\sqrt{-3(x-1)x^9 + 6c_1(9-8x)x^5 + 81{c_1}^2} + 9c_1\right)}}\right)$$

$$y(x) \to \frac{1}{48}\left(-16x^2 + 4i\left(\sqrt{3}+i\right)\sqrt[3]{(9-8x)x^5 + 3\left(\sqrt{-3(x-1)x^9 + 6c_1(9-8x)x^5 + 81{c_1}^2} + 9c_1\right)} + \frac{\left(-4-4i\sqrt{3}\right)(4x-3)x^3}{\sqrt[3]{(9-8x)x^5 + 3\left(\sqrt{-3(x-1)x^9 + 6c_1(9-8x)x^5 + 81{c_1}^2} + 9c_1\right)}}\right)$$

$$y(x) \to \frac{1}{48}\left(-16x^2 - 4\left(1+i\sqrt{3}\right)\sqrt[3]{(9-8x)x^5 + 3\left(\sqrt{-3(x-1)x^9 + 6c_1(9-8x)x^5 + 81{c_1}^2} + 9c_1\right)} + \frac{4i\left(\sqrt{3}+i\right)(4x-3)x^3}{\sqrt[3]{(9-8x)x^5 + 3\left(\sqrt{-3(x-1)x^9 + 6c_1(9-8x)x^5 + 81{c_1}^2} + 9c_1\right)}}\right)$$

3.2 problem Exact Differential equations. Exercise 9.5, page 79

Internal problem ID [3947]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 9
Problem number: Exact Differential equations. Exercise 9.5, page 79.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class D‘], _exact, _rational, [_Abel, ‘2nd typ`

$$\boxed{\frac{2xy+1}{y}+\frac{(y-x)\,y'}{y^2}=0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 18

```
dsolve((2*x*y(x)+1)/y(x)+(y(x)-x)/y(x)^2*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x)=-\frac{x}{\mathrm{LambertW}\left(-\mathrm{e}^{x^2}c_1x\right)}$$

✓ Solution by Mathematica

Time used: 6.22 (sec). Leaf size: 29

```
DSolve[(2*x*y[x]+1)/y[x]+(y[x]-x)/y[x]^2*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x)\to -\frac{x}{W\left(x\left(-e^{x^2-c_1}\right)\right)}$$

$$y(x)\to 0$$

3.3 problem Exact Differential equations. Exercise 9.6, page 79

Internal problem ID [3948]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 9
Problem number: Exact Differential equations. Exercise 9.6, page 79.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class A‘], _exact, _rational, _dAlembert]`

$$2xy + \left(y^2 + x^2\right) y' = 0$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 257

```
dsolve(2*x*y(x)+(x^2+y(x)^2)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{\frac{\left(4+4\sqrt{4x^6c_1^3+1}\right)^{\frac{1}{3}}}{2} - \frac{2x^2c_1}{\left(4+4\sqrt{4x^6c_1^3+1}\right)^{\frac{1}{3}}}}{\sqrt{c_1}}$$

$$y(x) = \frac{-\frac{\left(4+4\sqrt{4x^6c_1^3+1}\right)^{\frac{1}{3}}}{4} + \frac{x^2c_1}{\left(4+4\sqrt{4x^6c_1^3+1}\right)^{\frac{1}{3}}} - \frac{i\sqrt{3}\left(\frac{\left(4+4\sqrt{4x^6c_1^3+1}\right)^{\frac{1}{3}}}{2} + \frac{2x^2c_1}{\left(4+4\sqrt{4x^6c_1^3+1}\right)^{\frac{1}{3}}}\right)}{2}}{\sqrt{c_1}}$$

$$y(x) = \frac{-\frac{\left(4+4\sqrt{4x^6c_1^3+1}\right)^{\frac{1}{3}}}{4} + \frac{x^2c_1}{\left(4+4\sqrt{4x^6c_1^3+1}\right)^{\frac{1}{3}}} + \frac{i\sqrt{3}\left(\frac{\left(4+4\sqrt{4x^6c_1^3+1}\right)^{\frac{1}{3}}}{2} + \frac{2x^2c_1}{\left(4+4\sqrt{4x^6c_1^3+1}\right)^{\frac{1}{3}}}\right)}{2}}{\sqrt{c_1}}$$

✓ Solution by Mathematica

Time used: 15.759 (sec). Leaf size: 362

```
DSolve[2*x*y[x]+(x^2+y[x]^2)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{\sqrt[3]{\sqrt{4x^6+e^{6c_1}}+e^{3c_1}}}{\sqrt[3]{2}} - \frac{\sqrt[3]{2}x^2}{\sqrt[3]{\sqrt{4x^6+e^{6c_1}}+e^{3c_1}}}$$

$$y(x) \to \frac{2\sqrt[3]{-2}x^2 + (-2)^{2/3}\left(\sqrt{4x^6+e^{6c_1}}+e^{3c_1}\right)^{2/3}}{2\sqrt[3]{\sqrt{4x^6+e^{6c_1}}+e^{3c_1}}}$$

$$y(x) \to -\frac{2(-1)^{2/3}x^2 + \sqrt[3]{-2}\left(\sqrt{4x^6+e^{6c_1}}+e^{3c_1}\right)^{2/3}}{2^{2/3}\sqrt[3]{\sqrt{4x^6+e^{6c_1}}+e^{3c_1}}}$$

$$y(x) \to 0$$

$$y(x) \to \frac{1}{2}\sqrt[6]{x^6}\left(\frac{\left(1-i\sqrt{3}\right)\left(x^6\right)^{2/3}}{x^4} - i\sqrt{3} - 1\right)$$

$$y(x) \to \frac{1}{2}\sqrt[6]{x^6}\left(\frac{\left(1+i\sqrt{3}\right)\left(x^6\right)^{2/3}}{x^4} + i\sqrt{3} - 1\right)$$

$$y(x) \to \sqrt[6]{x^6} - \frac{\left(x^6\right)^{5/6}}{x^4}$$

3.4 problem Exact Differential equations. Exercise 9.7, page 79

Internal problem ID [3949]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 9
Problem number: Exact Differential equations. Exercise 9.7, page 79.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_exact]`

$$\boxed{e^x \sin(y) + e^{-y} - \left(x\, e^{-y} - e^x \cos(y)\right) y' = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 18

```
dsolve((exp(x)*sin(y(x))+exp(-y(x)))-(x*exp(-y(x))-exp(x)*cos(y(x)))*diff(y(x),x)=0,y(x), sin
```

$$e^x \sin(y(x)) + x\, e^{-y(x)} + c_1 = 0$$

✓ Solution by Mathematica

Time used: 0.411 (sec). Leaf size: 24

```
DSolve[(Exp[x]*Sin[y[x]]+Exp[-y[x]])-(x*Exp[-y[x]]-Exp[x]*Cos[y[x]])*y'[x]==0,y[x],x,IncludeS
```

$$\text{Solve}\left[x\left(-e^{-y(x)}\right) - e^x \sin(y(x)) = c_1, y(x)\right]$$

3.5 problem Exact Differential equations. Exercise 9.8, page 79

Internal problem ID [3950]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 9
Problem number: Exact Differential equations. Exercise 9.8, page 79.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_exact, [_1st_order, '_with_symmetry_[F(x)*G(y),0]']]`

$$\boxed{\cos(y) - \left(x \sin(y) - y^2\right) y' = 0}$$

✓ Solution by Maple

Time used: 0.032 (sec). Leaf size: 20

```
dsolve(cos(y(x))-(x*sin(y(x))-y(x)^2)*diff(y(x),x)=0,y(x), singsol=all)
```

$$x - \frac{-\frac{y(x)^3}{3} + c_1}{\cos(y(x))} = 0$$

✓ Solution by Mathematica

Time used: 0.129 (sec). Leaf size: 23

```
DSolve[Cos[y[x]]-(x*Sin[y[x]]-y[x]^2)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$\text{Solve}\left[x = -\frac{1}{3}y(x)^3 \sec(y(x)) + c_1 \sec(y(x)), y(x)\right]$$

3.6 problem Exact Differential equations. Exercise 9.9, page 79

Internal problem ID [3951]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 9
Problem number: Exact Differential equations. Exercise 9.9, page 79.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_exact]`

$$\boxed{x - 2xy + e^{y} + \left(y - x^{2} + x\,e^{y}\right) y' = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 28

```
dsolve((x-2*x*y(x)+exp(y(x)))+(y(x)-x^2+x*exp(y(x)))*diff(y(x),x)=0,y(x), singsol=all)
```

$$-y(x)\,x^{2} + x\,e^{y(x)} + \frac{x^{2}}{2} + \frac{y(x)^{2}}{2} + c_{1} = 0$$

✓ Solution by Mathematica

Time used: 0.323 (sec). Leaf size: 35

```
DSolve[(x-2*x*y[x]+Exp[y[x]])+(y[x]-x^2+x*Exp[y[x]])*y'[x]==0,y[x],x,IncludeSingularSolutions
```

$$\text{Solve}\left[x^{2}(-y(x)) + \frac{x^{2}}{2} + xe^{y(x)} + \frac{y(x)^{2}}{2} = c_{1}, y(x)\right]$$

3.7 problem Exact Differential equations. Exercise 9.10, page 79

Internal problem ID [3952]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 9
Problem number: Exact Differential equations. Exercise 9.10, page 79.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_exact]`

$$\boxed{x^2 - x + y^2 - (e^y - 2xy)\, y' = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 26

```
dsolve((x^2-x+y(x)^2)-(exp(y(x))-2*x*y(x))*diff(y(x),x)=0,y(x), singsol=all)
```

$$\frac{x^3}{3} + y(x)^2 x - \frac{x^2}{2} - e^{y(x)} + c_1 = 0$$

✓ Solution by Mathematica

Time used: 0.209 (sec). Leaf size: 32

```
DSolve[(x^2-x+y[x]^2)-(Exp[y[x]]-2*x*y[x])*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$\text{Solve}\left[-\frac{x^3}{3} + \frac{x^2}{2} - xy(x)^2 + e^{y(x)} = c_1, y(x)\right]$$

3.8 problem Exact Differential equations. Exercise 9.11, page 79

Internal problem ID [3953]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 9
Problem number: Exact Differential equations. Exercise 9.11, page 79.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_exact]`

$$\boxed{2x + y\cos(x) + (2y + \sin(x) - \sin(y))\, y' = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 20

```
dsolve((2*x+y(x)*cos(x))+(2*y(x)+sin(x)-sin(y(x)))*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x)\sin(x) + x^2 + y(x)^2 + \cos(y(x)) + c_1 = 0$$

✓ Solution by Mathematica

Time used: 0.203 (sec). Leaf size: 22

```
DSolve[(2*x+y[x]*Cos[x])+(2*y[x]+Sin[x]-Sin[y[x]])*y'[x]==0,y[x],x,IncludeSingularSolutions -
```

$$\text{Solve}\left[x^2 + y(x)^2 + y(x)\sin(x) + \cos(y(x)) = c_1, y(x)\right]$$

3.9 problem Exact Differential equations. Exercise 9.12, page 79

Internal problem ID [3954]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 9
Problem number: Exact Differential equations. Exercise 9.12, page 79.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class A‘], _exact, _dAlembert]`

$$\boxed{x\sqrt{y^2+x^2}-\frac{x^2yy'}{y-\sqrt{y^2+x^2}}=0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 19

```
dsolve(x*sqrt(x^2+y(x)^2)-(x^2*y(x))/(y(x)- sqrt(x^2+y(x)^2))*diff(y(x),x)=0,y(x), singsol=al
```

$$c_1+\left(x^2+y(x)^2\right)^{\frac{3}{2}}+y(x)^3=0$$

✓ Solution by Mathematica

Time used: 60.268 (sec). Leaf size: 2125

```
DSolve[x*Sqrt[x^2+y[x]^2]-(x^2*y[x])/(y[x]- Sqrt[x^2+y[x]^2])*y'[x]==0,y[x],x,IncludeSingular
```

$$y(x) \to -\frac{x^2\sqrt{\frac{e^{6c_1}}{x^4}-6x^2+\frac{3(5x^6-4e^{6c_1})}{\sqrt[3]{-11x^{12}+14e^{6c_1}x^6+2\sqrt{(-x^6+e^{6c_1})(x^6+e^{6c_1})^3}-2e^{12c_1}}}+\frac{3\sqrt[3]{-11x^{12}+14e^{6c_1}}}{}}}{}$$

$$y(x) \to \frac{x^2\left(-\sqrt{\frac{e^{6c_1}}{x^4}-6x^2+\frac{3(5x^6-4e^{6c_1})}{\sqrt[3]{-11x^{12}+14e^{6c_1}x^6+2\sqrt{(-x^6+e^{6c_1})(x^6+e^{6c_1})^3}-2e^{12c_1}}}+\frac{3\sqrt[3]{-11x^{12}+14e^{6}}}{}}\right.}{}$$

$$y(x) \to \frac{x^2\sqrt{\frac{e^{6c_1}}{x^4}-6x^2+\frac{3(5x^6-4e^{6c_1})}{\sqrt[3]{-11x^{12}+14e^{6c_1}x^6+2\sqrt{(-x^6+e^{6c_1})(x^6+e^{6c_1})^3}-2e^{12c_1}}}+\frac{3\sqrt[3]{-11x^{12}+14e^{6c_1}x^6}}{}}}{}$$

$$y(x) \to \frac{x^2\sqrt{\frac{e^{6c_1}}{x^4}-6x^2+\frac{3(5x^6-4e^{6c_1})}{\sqrt[3]{-11x^{12}+14e^{6c_1}x^6+2\sqrt{(-x^6+e^{6c_1})(x^6+e^{6c_1})^3}-2e^{12c_1}}}+\frac{3\sqrt[3]{-11x^{12}+14e^{6c_1}x^6}}{}}}{}$$

3.10 problem Exact Differential equations. Exercise 9.13, page 79

Internal problem ID [3955]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 9
Problem number: Exact Differential equations. Exercise 9.13, page 79.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_exact]`

$$\boxed{4x^3 - \sin(x) + y^3 - (y^2 + 1 - 3xy^2)\, y' = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 1162

```
dsolve((4*x^3-sin(x)+y(x)^3)-(y(x)^2+1-3*x*y(x)^2)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{\left(\left(-12x^4 + 4\sqrt{\frac{27x^9-9x^8+54\cos(x)x^5+54c_1x^5-18\cos(x)x^4-18c_1x^4+27x\cos(x)^2+54c_1x\cos(x)+27c_1^2x-9\cos(x)^2-18c_1\cos(x)-9c_1^2-\cdots}{3x-1}}\cdots\right.\right.}{6x-2} + \frac{2}{\left(\left(-12x^4 + 4\sqrt{\frac{27x^9-9x^8+54\cos(x)x^5+54c_1x^5-18\cos(x)x^4-18c_1x^4+27x\cos(x)^2+54c_1x\cos(x)+27c_1^2x-9\cos(x)^2-18c_1\cos(x)-9c\cdots}{3x-1}}\cdots\right.\right.}$$

$$y(x) = -\frac{\left(\left(-12x^4 + 4\sqrt{\frac{27x^9-9x^8+54\cos(x)x^5+54c_1x^5-18\cos(x)x^4-18c_1x^4+27x\cos(x)^2+54c_1x\cos(x)+27c_1^2x-9\cos(x)^2-18c_1\cos(x)-9c\cdots}{3x-1}}\cdots\right.\right.}{4(3x-1)} - \frac{1}{\left(\left(-12x^4 + 4\sqrt{\frac{27x^9-9x^8+54\cos(x)x^5+54c_1x^5-18\cos(x)x^4-18c_1x^4+27x\cos(x)^2+54c_1x\cos(x)+27c_1^2x-9\cos(x)^2-18c_1\cos(x)-9c\cdots}{3x-1}}\cdots\right.\right.} - \frac{i\sqrt{3}\left(\frac{\left(\left(-12x^4+4\sqrt{\frac{27x^9-9x^8+54\cos(x)x^5+54c_1x^5-18\cos(x)x^4-18c_1x^4+27x\cos(x)^2+54c_1x\cos(x)+27c_1^2x-9\cos(x)^2-18c_1\cos(x)-9c_1^2-4}{3x-1}}-12\cos\cdots\right.\right.}{6x-2}\cdots\right.}{\cdots}$$

$$y(x) = -\frac{\left(\left(-12x^4 + 4\sqrt{\frac{27x^9-9x^8+54\cos(x)x^5+54c_1x^5-18\cos(x)x^4-18c_1x^4+27x\cos(x)^2+54c_1x\cos(x)+27c_1^2x-9\cos(x)^2-18c_1\cos(x)-9c\cdots}{3x-1}}\cdots\right.\right.}{4(3x-1)} - \frac{1}{\left(\left(-12x^4 + 4\sqrt{\frac{27x^9-9x^8+54\cos(x)x^5+54c_1x^5-18\cos(x)x^4-18c_1x^4+27x\cos(x)^2+54c_1x\cos(x)+27c_1^2x-9\cos(x)^2-18c_1\cos(x)-9c\cdots}{3x-1}}\cdots\right.\right.} + \frac{i\sqrt{3}\left(\frac{\left(\left(-12x^4+4\sqrt{\frac{27x^9-9x^8+54\cos(x)x^5+54c_1x^5-18\cos(x)x^4-18c_1x^4+27x\cos(x)^2+54c_1x\cos(x)+27c_1^2x-9\cos(x)^2-18c_1\cos(x)-9c_1^2-4}{3x-1}}-12\cos\cdots\right.\right.}{6x-2}\cdots\right.}{\cdots}$$

✓ Solution by Mathematica

Time used: 60.211 (sec). Leaf size: 567

```
DSolve[(4*x^3-Sin[x]+y[x]^3)-(y[x]^2+1-3*x*y[x]^2)*y'[x]==0,y[x],x,IncludeSingularSolutions -
```

$$y(x) \to \frac{\sqrt[3]{2}\left(-3(1-3x)^2\left(x^4-c_1\right)+\frac{1}{27}\sqrt{4(9-27x)^3+6561(1-3x)^4\left(x^4+\cos(x)-c_1\right)^2}-3(1-3x)^2\cos(x)\right)}{2^{2/3}(3x-1)\sqrt[3]{-3(1-3x)^2\left(x^4-c_1\right)+\frac{1}{27}\sqrt{4(9-27x)^3+6561(1-3x)^4\left(x^4+\cos(x)-c_1\right)^2}-3(1-}}$$

$$y(x) \to \frac{9i\sqrt[3]{2}\left(\sqrt{3}+i\right)\left(-3(1-3x)^2\left(x^4-c_1\right)+\frac{1}{27}\sqrt{4(9-27x)^3+6561(1-3x)^4\left(x^4+\cos(x)-c_1\right)^2}-3(1-3\right.}{18\,2^{2/3}(3x-1)\sqrt[3]{-3(1-3x)^2\left(x^4-c_1\right)+\frac{1}{27}\sqrt{4(9-27x)^3+6561(1-3x)^4\left(x^4+\cos(x)-\right.}}}$$

$$y(x) \to \frac{i\left(2\left(\sqrt{3}+i\right)-\frac{\sqrt[3]{2}\left(\sqrt{3}-i\right)\left(-3(1-3x)^2\left(x^4-c_1\right)+\frac{1}{27}\sqrt{4(9-27x)^3+6561(1-3x)^4\left(x^4+\cos(x)-c_1\right)^2}-3(1-3x)^2\cos(x)\right)^{2/3}}{3x-1}\right)}{2\,2^{2/3}\sqrt[3]{-3(1-3x)^2\left(x^4-c_1\right)+\frac{1}{27}\sqrt{4(9-27x)^3+6561(1-3x)^4\left(x^4+\cos(x)-c_1\right)^2}-3(1-3x)^2\cos}}$$

3.11 problem Exact Differential equations. Exercise 9.15, page 79

Internal problem ID [3956]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 9
Problem number: Exact Differential equations. Exercise 9.15, page 79.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_exact, _Bernoulli]`

$$\boxed{\mathrm{e}^{x}\left(y^{3}+y^{3}x+1\right)+3y^{2}\left(\mathrm{e}^{x}x-6\right)y'=0}$$

With initial conditions

$$[y(0)=1]$$

✓ Solution by Maple

Time used: 0.141 (sec). Leaf size: 38

```
dsolve([exp(x)*(y(x)^3+x*y(x)^3+1)+3*y(x)^2*(x*exp(x)-6)*diff(y(x),x)=0,y(0) = 1],y(x), sings
```

$$y(x)=\frac{\left(-1+i\sqrt{3}\right)\left(-\left(\mathrm{e}^{x}+5\right)\left(\mathrm{e}^{x}x-6\right)^{2}\right)^{\frac{1}{3}}}{2\,\mathrm{e}^{x}x-12}$$

✓ Solution by Mathematica

Time used: 1.149 (sec). Leaf size: 28

```
DSolve[{Exp[x]*(y[x]^3+x*y[x]^3+1)+3*y[x]^2*(x*Exp[x]-6)*y'[x]==0,y[0]==1},y[x],x,IncludeSing
```

$$y(x)\to\frac{\sqrt[3]{-e^{x}-5}}{\sqrt[3]{e^{x}x-6}}$$

3.12 problem Exact Differential equations. Exercise 9.16, page 79

Internal problem ID [3957]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 9
Problem number: Exact Differential equations. Exercise 9.16, page 79.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_separable]`

$$\boxed{\sin(x)\cos(y) + \cos(x)\sin(y)\, y' = 0}$$

With initial conditions

$$\left[y\left(\frac{\pi}{4}\right) = \frac{\pi}{4}\right]$$

✓ Solution by Maple

Time used: 0.328 (sec). Leaf size: 11

```
dsolve([sin(x)*cos(y(x))+cos(x)*sin(y(x))*diff(y(x),x)=0,y(1/4*Pi) = 1/4*Pi],y(x), singsol=al
```

$$y(x) = \arccos\left(\frac{\sec(x)}{2}\right)$$

✓ Solution by Mathematica

Time used: 6.213 (sec). Leaf size: 10

```
DSolve[{Sin[x]*Cos[y[x]]+Cos[x]*Sin[y[x]]*y'[x]==0,y[Pi/4]==Pi/4},y[x],x,IncludeSingularSolut
```

$$y(x) \to \sec^{-1}(2\cos(x))$$

3.13 problem Exact Differential equations. Exercise 9.17, page 79

Internal problem ID [3958]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 9
Problem number: Exact Differential equations. Exercise 9.17, page 79.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_exact]`

$$y^2 e^{x y^2} + 4x^3 + \left(2xy\, e^{x y^2} - 3y^2\right) y' = 0$$

With initial conditions

$$[y(1) = 0]$$

✓ Solution by Maple

Time used: 0.063 (sec). Leaf size: 23

```
dsolve([(y(x)^2*exp(x*y(x)^2)+4*x^3)+(2*x*y(x)*exp(x*y(x)^2)-3*y(x)^2)*diff(y(x),x)=0,y(1) =
```

$$y(x) = \operatorname{RootOf}\left(-e^{\_Z^2 x} - x^4 + \_Z^3 + 2\right)$$

✓ Solution by Mathematica

Time used: 0.34 (sec). Leaf size: 23

```
DSolve[{(y[x]^2*Exp[x*y[x]^2]+4*x^3)+(2*x*y[x]*Exp[x*y[x]^2]-3*y[x]^2)*y'[x]==0,y[1]==0},y[x]
```

$$\text{Solve}\left[x^4 + e^{x y(x)^2} - y(x)^3 = 2, y(x)\right]$$

4 Chapter 2. Special types of differential equations of the first kind. Lesson 10

4.1 problem Recognizable Exact Differential equations. Integrating factors. Example 10.51, page 90

Internal problem ID [3959]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Example 10.51, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_separable]`

$$\boxed{y^2 + y - y'x = 0}$$

✓ Solution by Maple

Time used: 0.015 (sec). Leaf size: 13

```
dsolve((y(x)^2+y(x))-x*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{x}{c_1 - x}$$

✓ Solution by Mathematica

Time used: 0.275 (sec). Leaf size: 28

```
DSolve[(y[x]^2+y[x])-x*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -1 + \frac{1}{1 - e^{c_1}x}$$
$$y(x) \to -1$$
$$y(x) \to 0$$

4.2 problem Recognizable Exact Differential equations. Integrating factors. Example 10.52, page 90

Internal problem ID [3960]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Example 10.52, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_separable]`

$$\boxed{y\sec(x) + y'\sin(x) = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 10

```
dsolve((y(x)*sec(x))+sin(x)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{c_1}{\tan(x)}$$

✓ Solution by Mathematica

Time used: 0.035 (sec). Leaf size: 15

```
DSolve[(y[x]*Sec[x])+Sin[x]*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to c_1 \cot(x)$$
$$y(x) \to 0$$

4.3 problem Recognizable Exact Differential equations. Integrating factors. Example 10.661, page 90

Internal problem ID [3961]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Example 10.661, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[‘y=_G(x,y’)‘]`

$$\boxed{e^x - \sin(y) + \cos(y) y' = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 13

```
dsolve((exp(x)-sin(y(x)))+cos(y(x))*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = -\arcsin\left((x + c_1) e^x\right)$$

✓ Solution by Mathematica

Time used: 11.785 (sec). Leaf size: 16

```
DSolve[(Exp[x]-Sin[y[x]])+Cos[y[x]]*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -\arcsin\left(e^x (x + c_1)\right)$$

4.4 problem Recognizable Exact Differential equations. Integrating factors. Example 10.701, page 90

Internal problem ID [3962]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Example 10.701, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_separable]`

$$\boxed{xy + \left(x^2 + 1\right) y' = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 13

```
dsolve((x*y(x))+(1+x^2)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{c_1}{\sqrt{x^2 + 1}}$$

✓ Solution by Mathematica

Time used: 0.027 (sec). Leaf size: 22

```
DSolve[(x*y[x])+(1+x^2)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{c_1}{\sqrt{x^2 + 1}}$$
$$y(x) \to 0$$

4.5 problem Recognizable Exact Differential equations. Integrating factors. Example 10.741, page 90

Internal problem ID [3963]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Example 10.741, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_rational, [_Abel, '2nd type', 'class C']]`

$$\boxed{y^3 + xy^2 + y + (x^3 + x^2y + x)\, y' = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 118

```
dsolve((y(x)^3+x*y(x)^2+y(x))+(x^3+x^2*y(x)+x)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{x^4 + 2x^2 + 1}{x\left(\sqrt{\frac{c_1x^4 + c_1x^2 - 1}{x^2(x^2+1)}}\,(x^2+1)^{\frac{3}{2}} - x^2 - 1\right)}$$

$$y(x) = -\frac{x^4 + 2x^2 + 1}{x\left(x^2 + \sqrt{\frac{c_1x^4 + c_1x^2 - 1}{x^2(x^2+1)}}\,(x^2+1)^{\frac{3}{2}} + 1\right)}$$

✓ Solution by Mathematica

Time used: 3.753 (sec). Leaf size: 96

```
DSolve[(y[x]^3+x*y[x]^2+y[x])+(x^3+x^2*y[x]+x)*y'[x]==0,y[x],x,IncludeSingularSolutions -> Tr
```

$$y(x) \to \frac{x^2 + 1}{x\left(-1 + \sqrt{\frac{1}{x^3}}\,x\sqrt{-\frac{1}{x} + c_1x(x^2+1)}\right)}$$

$$y(x) \to -\frac{x^2 + 1}{x + \sqrt{\frac{1}{x^3}}\,x^2\sqrt{-\frac{1}{x} + c_1x(x^2+1)}}$$

$$y(x) \to 0$$

4.6 problem Recognizable Exact Differential equations. Integrating factors. Example 10.781, page 90

Internal problem ID [3964]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Example 10.781, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_separable]`

$$\boxed{3y - y'x = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 9

```
dsolve((3*y(x))-(x)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = c_1 x^3$$

✓ Solution by Mathematica

Time used: 0.022 (sec). Leaf size: 16

```
DSolve[(3*y[x])-(x)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to c_1 x^3$$
$$y(x) \to 0$$

4.7 problem Recognizable Exact Differential equations. Integrating factors. Example 10.81, page 90

Internal problem ID [3965]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Example 10.81, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_separable]`

$$\boxed{y - 3y'x = 0}$$

✓ Solution by Maple

Time used: 0.015 (sec). Leaf size: 9

```
dsolve((y(x))-(3*x)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = c_1 x^{\frac{1}{3}}$$

✓ Solution by Mathematica

Time used: 0.022 (sec). Leaf size: 18

```
DSolve[(y[x])-(3*x)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to c_1 \sqrt[3]{x}$$
$$y(x) \to 0$$

4.8 problem Recognizable Exact Differential equations. Integrating factors. Example 10.83, page 90

Internal problem ID [3966]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Example 10.83, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class G‘], _rational]`

$$\boxed{y(2y^3x^2+3)+x(y^3x^2-1)\,y'=0}$$

✓ Solution by Maple

Time used: 0.046 (sec). Leaf size: 39

```
dsolve((y(x)*(2*x^2*y(x)^3+3))+(x*(x^2*y(x)^3-1))*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x)=\frac{\mathrm{e}^{-\frac{11c_1}{3}}x^3}{\operatorname{RootOf}\left(11\,\mathrm{e}^{11c_1}\_Z^{15}-\mathrm{e}^{11c_1}\_Z^{11}+4x^{11}\right)^5}$$

✓ Solution by Mathematica

Time used: 10.637 (sec). Leaf size: 1081

```
DSolve[(y[x]*(2*x^2*y[x]^3+3))+(x*(x^2*y[x]^3-1))*y'[x]==0,y[x],x,IncludeSingularSolutions ->
```

$$y(x) \to \text{Root}\left[1024\#1^{15}x^{22} + 14080\#1^{12}x^{20} + 77440\#1^{9}x^{18} + 212960\#1^{6}x^{16} - \#1^{4}e^{\frac{44c_1}{3}} + 292820\#1^{3}x^{14} + 161051x^{12}\&, 1\right]$$

$$y(x) \to \text{Root}\left[1024\#1^{15}x^{22} + 14080\#1^{12}x^{20} + 77440\#1^{9}x^{18} + 212960\#1^{6}x^{16} - \#1^{4}e^{\frac{44c_1}{3}} + 292820\#1^{3}x^{14} + 161051x^{12}\&, 2\right]$$

$$y(x) \to \text{Root}\left[1024\#1^{15}x^{22} + 14080\#1^{12}x^{20} + 77440\#1^{9}x^{18} + 212960\#1^{6}x^{16} - \#1^{4}e^{\frac{44c_1}{3}} + 292820\#1^{3}x^{14} + 161051x^{12}\&, 3\right]$$

$$y(x) \to \text{Root}\left[1024\#1^{15}x^{22} + 14080\#1^{12}x^{20} + 77440\#1^{9}x^{18} + 212960\#1^{6}x^{16} - \#1^{4}e^{\frac{44c_1}{3}} + 292820\#1^{3}x^{14} + 161051x^{12}\&, 4\right]$$

$$y(x) \to \text{Root}\left[1024\#1^{15}x^{22} + 14080\#1^{12}x^{20} + 77440\#1^{9}x^{18} + 212960\#1^{6}x^{16} - \#1^{4}e^{\frac{44c_1}{3}} + 292820\#1^{3}x^{14} + 161051x^{12}\&, 5\right]$$

$$y(x) \to \text{Root}\left[1024\#1^{15}x^{22} + 14080\#1^{12}x^{20} + 77440\#1^{9}x^{18} + 212960\#1^{6}x^{16} - \#1^{4}e^{\frac{44c_1}{3}} + 292820\#1^{3}x^{14} + 161051x^{12}\&, 6\right]$$

$$y(x) \to \text{Root}\left[1024\#1^{15}x^{22} + 14080\#1^{12}x^{20} + 77440\#1^{9}x^{18} + 212960\#1^{6}x^{16} - \#1^{4}e^{\frac{44c_1}{3}} + 292820\#1^{3}x^{14} + 161051x^{12}\&, 7\right]$$

$$y(x) \to \text{Root}\left[1024\#1^{15}x^{22} + 14080\#1^{12}x^{20} + 77440\#1^{9}x^{18} + 212960\#1^{6}x^{16} - \#1^{4}e^{\frac{44c_1}{3}} + 292820\#1^{3}x^{14} + 161051x^{12}\&, 8\right]$$

$$y(x) \to \text{Root}\left[1024\#1^{15}x^{22} + 14080\#1^{12}x^{20} + 77440\#1^{9}x^{18} + 212960\#1^{6}x^{16} - \#1^{4}e^{\frac{44c_1}{3}} + 292820\#1^{3}x^{14} + 161051x^{12}\&, 9\right]$$

$$y(x) \to \text{Root}\left[1024\#1^{15}x^{22} + 14080\#1^{12}x^{20} + 77440\#1^{9}x^{18} + 212960\#1^{6}x^{16} - \#1^{4}e^{\frac{44c_1}{3}} + 292820\#1^{3}x^{14} + 161051x^{12}\&, 10\right]$$

$$y(x) \to \text{Root}\left[1024\#1^{15}x^{22} + 14080\#1^{12}x^{20} + 77440\#1^{9}x^{18} + 212960\#1^{6}x^{16} - \#1^{4}e^{\frac{44c_1}{3}} + 292820\#1^{3}x^{14} + 161051x^{12}\&, 11\right]$$

4.9 problem Recognizable Exact Differential equations. Integrating factors. Exercise 10.1, page 90

Internal problem ID [3967]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Exercise 10.1, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class A‘], _exact, _rational, _dAlembert]`

$$\boxed{2xy + x^2 + \left(y^2 + x^2\right) y' = 0}$$

✓ Solution by Maple

Time used: 0.047 (sec). Leaf size: 417

```
dsolve((2*x*y(x)+x^2)+(x^2+y(x)^2)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{\frac{\left(4-4x^3c_1^{\frac{3}{2}}+4\sqrt{5x^6c_1^3-2x^3c_1^{\frac{3}{2}}+1}\right)^{\frac{1}{3}}}{2} - \frac{2x^2c_1}{\left(4-4x^3c_1^{\frac{3}{2}}+4\sqrt{5x^6c_1^3-2x^3c_1^{\frac{3}{2}}+1}\right)^{\frac{1}{3}}}}{\sqrt{c_1}}$$

$$y(x) = \frac{-\frac{\left(4-4x^3c_1^{\frac{3}{2}}+4\sqrt{5x^6c_1^3-2x^3c_1^{\frac{3}{2}}+1}\right)^{\frac{1}{3}}}{4} + \frac{x^2c_1}{\left(4-4x^3c_1^{\frac{3}{2}}+4\sqrt{5x^6c_1^3-2x^3c_1^{\frac{3}{2}}+1}\right)^{\frac{1}{3}}} - \frac{i\sqrt{3}\left(\frac{\left(4-4x^3c_1^{\frac{3}{2}}+4\sqrt{5x^6c_1^3-2x^3c_1^{\frac{3}{2}}+1}\right)^{\frac{1}{3}}}{2} + \frac{\cdots}{\left(4-4x^3c_1^{\frac{3}{2}}+4\sqrt{\cdots}\right.\cdots}\right.\cdots}{2}\cdots}{\sqrt{c_1}}$$

$$y(x) = \frac{-\frac{\left(4-4x^3c_1^{\frac{3}{2}}+4\sqrt{5x^6c_1^3-2x^3c_1^{\frac{3}{2}}+1}\right)^{\frac{1}{3}}}{4} + \frac{x^2c_1}{\left(4-4x^3c_1^{\frac{3}{2}}+4\sqrt{5x^6c_1^3-2x^3c_1^{\frac{3}{2}}+1}\right)^{\frac{1}{3}}} + \frac{i\sqrt{3}\left(\frac{\left(4-4x^3c_1^{\frac{3}{2}}+4\sqrt{5x^6c_1^3-2x^3c_1^{\frac{3}{2}}+1}\right)^{\frac{1}{3}}}{2} + \frac{\cdots}{\left(4-4x^3c_1^{\frac{3}{2}}+4\sqrt{\cdots}\right.\cdots}\right.\cdots}{2}\cdots}{\sqrt{c_1}}$$

✓ Solution by Mathematica

Time used: 23.479 (sec). Leaf size: 544

```
DSolve[(2*x*y[x]+x^2)+(x^2+y[x]^2)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{\sqrt[3]{-x^3+\sqrt{5x^6-2e^{3c_1}x^3+e^{6c_1}}+e^{3c_1}}}{\sqrt[3]{2}} - \frac{\sqrt[3]{2}x^2}{\sqrt[3]{-x^3+\sqrt{5x^6-2e^{3c_1}x^3+e^{6c_1}}+e^{3c_1}}}$$

$$y(x) \to \frac{2\sqrt[3]{-2}x^2+(-2)^{2/3}\left(-x^3+\sqrt{5x^6-2e^{3c_1}x^3+e^{6c_1}}+e^{3c_1}\right)^{2/3}}{2\sqrt[3]{-x^3+\sqrt{5x^6-2e^{3c_1}x^3+e^{6c_1}}+e^{3c_1}}}$$

$$y(x) \to -\frac{2(-1)^{2/3}x^2+\sqrt[3]{-2}\left(-x^3+\sqrt{5x^6-2e^{3c_1}x^3+e^{6c_1}}+e^{3c_1}\right)^{2/3}}{2^{2/3}\sqrt[3]{-x^3+\sqrt{5x^6-2e^{3c_1}x^3+e^{6c_1}}+e^{3c_1}}}$$

$$y(x) \to \frac{2\sqrt[3]{-2}x^2+(-2)^{2/3}\left(\sqrt{5}\sqrt{x^6}-x^3\right)^{2/3}}{2\sqrt[3]{\sqrt{5}\sqrt{x^6}-x^3}}$$

$$y(x) \to \frac{\left(2\sqrt{5}\sqrt{x^6}-2x^3\right)^{2/3}-2\sqrt[3]{2}x^2}{2\sqrt[3]{\sqrt{5}\sqrt{x^6}-x^3}}$$

$$y(x) \to -\frac{2(-1)^{2/3}x^2+\sqrt[3]{-2}\left(\sqrt{5}\sqrt{x^6}-x^3\right)^{2/3}}{2^{2/3}\sqrt[3]{\sqrt{5}\sqrt{x^6}-x^3}}$$

4.10 problem Recognizable Exact Differential equations. Integrating factors. Exercise 10.2, page 90

Internal problem ID [3968]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Exercise 10.2, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_exact]`

$$x^2 + y\cos(x) + (y^3 + \sin(x))\,y' = 0$$

✓ Solution by Maple

Time used: 0.015 (sec). Leaf size: 21

```
dsolve((x^2+y(x)*cos(x))+(y(x)^3+sin(x))*diff(y(x),x)=0,y(x), singsol=all)
```

$$\frac{x^3}{3} + y(x)\sin(x) + \frac{y(x)^4}{4} + c_1 = 0$$

✓ Solution by Mathematica

Time used: 60.206 (sec). Leaf size: 1119

```
DSolve[(x^2+y[x]*Cos[x])+(y[x]^3+Sin[x])*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{\sqrt{\frac{4x^3+\left(27\sin^2(x)+\sqrt{729\sin^4(x)-64(x^3-3c_1)^3}\right)^{2/3}-12c_1}{\sqrt[3]{27\sin^2(x)+\sqrt{729\sin^4(x)-64\left(x^3-3c_1\right)^3}}}}}{\sqrt{6}} - \frac{1}{2}\sqrt{-\frac{8\left(x^3-3c_1\right)}{3\sqrt[3]{27\sin^2(x)+\sqrt{729\sin^4(x)-64\left(x^3-3c_1\right)^3}}} - \frac{2}{3}\sqrt[3]{27\sin^2(x)+\sqrt{729\sin^4(x)-64\left(x^3-3c_1\right)}}}$$

$$y(x) \to \frac{\sqrt{\frac{4x^3+\left(27\sin^2(x)+\sqrt{729\sin^4(x)-64(x^3-3c_1)^3}\right)^{2/3}-12c_1}{\sqrt[3]{27\sin^2(x)+\sqrt{729\sin^4(x)-64\left(x^3-3c_1\right)^3}}}}}{\sqrt{6}} + \frac{1}{2}\sqrt{-\frac{8\left(x^3-3c_1\right)}{3\sqrt[3]{27\sin^2(x)+\sqrt{729\sin^4(x)-64\left(x^3-3c_1\right)^3}}} - \frac{2}{3}\sqrt[3]{27\sin^2(x)+\sqrt{729\sin^4(x)-64\left(x^3-3c_1\right)}}}$$

$$y(x) \to -\frac{\sqrt{\frac{4x^3+\left(27\sin^2(x)+\sqrt{729\sin^4(x)-64(x^3-3c_1)^3}\right)^{2/3}-12c_1}{\sqrt[3]{27\sin^2(x)+\sqrt{729\sin^4(x)-64\left(x^3-3c_1\right)^3}}}}}{\sqrt{6}} - \frac{1}{2}\sqrt{-\frac{8\left(x^3-3c_1\right)}{3\sqrt[3]{27\sin^2(x)+\sqrt{729\sin^4(x)-64\left(x^3-3c_1\right)^3}}} - \frac{2}{3}\sqrt[3]{27\sin^2(x)+\sqrt{729\sin^4(x)-64\left(x^3-3c_1\right)}}}$$

$$y(x) \to \frac{1}{2}\sqrt{-\frac{8\left(x^3-3c_1\right)}{3\sqrt[3]{27\sin^2(x)+\sqrt{729\sin^4(x)-64\left(x^3-3c_1\right)^3}}} - \frac{2}{3}\sqrt[3]{27\sin^2(x)+\sqrt{729\sin^4(x)-64\left(x^3-3c_1\right)^3}}} \sqrt{\frac{4x^3+\left(27\sin^2(x)+\sqrt{729\sin^4(x)-64(x^3-3c_1)^3}\right)^{2/3}-12c_1}{\sqrt[3]{27\sin^2(x)+\sqrt{729\sin^4(x)-64\left(x^3-3c_1\right)^3}}}}$$

4.11 problem Recognizable Exact Differential equations. Integrating factors. Exercise 10.3, page 90

Internal problem ID [3969]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Exercise 10.3, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_rational, _Bernoulli]`

$$\boxed{x^2 + y^2 + x + xyy' = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 49

```
dsolve((x^2+y(x)^2+x)+(x*y(x))*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = -\frac{\sqrt{-18x^4 - 24x^3 + 36c_1}}{6x}$$
$$y(x) = \frac{\sqrt{-18x^4 - 24x^3 + 36c_1}}{6x}$$

✓ Solution by Mathematica

Time used: 0.262 (sec). Leaf size: 56

```
DSolve[(x^2+y[x]^2+x)+(x*y[x])*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -\frac{\sqrt{-\frac{1}{6}x^3(3x+4) + c_1}}{x}$$
$$y(x) \to \frac{\sqrt{-\frac{1}{6}x^3(3x+4) + c_1}}{x}$$

4.12 problem Recognizable Exact Differential equations. Integrating factors. Exercise 10.4, page 90

Internal problem ID [3970]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Exercise 10.4, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_exact]`

$$\boxed{x - 2xy + e^{y} + \left(y - x^{2} + x\,e^{y}\right) y' = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 28

```
dsolve((x-2*x*y(x)+exp(y(x)))+(y(x)-x^2+x*exp(y(x)))*diff(y(x),x)=0,y(x), singsol=all)
```

$$-y(x)\,x^{2} + x\,e^{y(x)} + \frac{x^{2}}{2} + \frac{y(x)^{2}}{2} + c_1 = 0$$

✓ Solution by Mathematica

Time used: 0.334 (sec). Leaf size: 35

```
DSolve[(x-2*x*y[x]+Exp[y[x]])+(y[x]-x^2+x*Exp[y[x]])*y'[x]==0,y[x],x,IncludeSingularSolutions
```

$$\text{Solve}\left[x^{2}(-y(x)) + \frac{x^{2}}{2} + xe^{y(x)} + \frac{y(x)^{2}}{2} = c_1, y(x)\right]$$

4.13 problem Recognizable Exact Differential equations. Integrating factors. Exercise 10.5, page 90

Internal problem ID [3971]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Exercise 10.5, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_exact]`

$$
\boxed{e^{x} \sin \left(y\right)+e^{-y}-\left(x\,e^{-y}-e^{x} \cos \left(y\right)\right) y^{\prime}=0}
$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 18

```
dsolve((exp(x)*sin(y(x))+exp(-y(x)))-(x*exp(-y(x))-exp(x)*cos(y(x)))*diff(y(x),x)=0,y(x), sin
```

$$
e^{x} \sin \left(y \left(x\right)\right)+x\,e^{-y\left(x\right)}+c_{1}=0
$$

✓ Solution by Mathematica

Time used: 0.373 (sec). Leaf size: 24

```
DSolve[(Exp[x]*Sin[y[x]]+Exp[-y[x]])-(x*Exp[-y[x]]-Exp[x]*Cos[y[x]])*y'[x]==0,y[x],x,IncludeS
```

$$
\text{Solve}\left[x\left(-e^{-y(x)}\right)-e^{x}\sin(y(x))=c_{1},y(x)\right]
$$

4.14 problem Recognizable Exact Differential equations. Integrating factors. Exercise 10.6, page 90

Internal problem ID [3972]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Exercise 10.6, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_1st_order, _with_linear_symmetries], _rational]`

$$\boxed{x^2 - y^2 - y - (x^2 - y^2 - x)\, y' = 0}$$

✓ Solution by Maple

Time used: 0.125 (sec). Leaf size: 28

```
dsolve((x^2-y(x)^2-y(x))-(x^2-y(x)^2-x)*diff(y(x),x)=0,y(x), singsol=all)
```

$$-2y(x) + \ln(x + y(x)) - \ln(y(x) - x) + 2x - c_1 = 0$$

✓ Solution by Mathematica

Time used: 0.243 (sec). Leaf size: 32

```
DSolve[(x^2-y[x]^2-y[x])-(x^2-y[x]^2-x)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$\text{Solve}\left[-\frac{e^{2x-2y(x)}(y(x)+x)}{2(x-y(x))} = c_1, y(x)\right]$$

4.15 problem Recognizable Exact Differential equations. Integrating factors. Exercise 10.7, page 90

Internal problem ID [3973]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Exercise 10.7, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_rational]`

$$\boxed{x^4y^2 - y + \left(x^2y^4 - x\right) y' = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 25

```
dsolve((x^4*y(x)^2-y(x))+(x^2*y(x)^4-x)*diff(y(x),x)=0,y(x), singsol=all)
```

$$-\frac{x^3}{3} - \frac{1}{xy\left(x\right)} - \frac{y(x)^3}{3} + c_1 = 0$$

✓ Solution by Mathematica

Time used: 60.13 (sec). Leaf size: 1427

```
DSolve[(x^4*y[x]^2-y[x])+(x^2*y[x]^4-x)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{4}\left(\sqrt{2}\sqrt{\frac{8\sqrt[3]{2}x+2^{2/3}\left(x^3\left(x^3-3c_1\right)^2+\sqrt{x^3\left(-256+x^3\left(x^3-3c_1\right)^4\right)}\right)^{2/3}}{x\sqrt[3]{x^3\left(x^3-3c_1\right)^2+\sqrt{x^3\left(-256+x^3\left(x^3-3c_1\right)^4\right)}}}}\right.$$

$$-2\sqrt{-\frac{2\sqrt{2}\left(x^3-3c_1\right)}{\sqrt{\frac{8\sqrt[3]{2}x+2^{2/3}\left(x^3\left(x^3-3c_1\right)^2+\sqrt{x^3\left(-256+x^3\left(x^3-3c_1\right)^4\right)}\right)^{2/3}}{x\sqrt[3]{x^3\left(x^3-3c_1\right)^2+\sqrt{x^3\left(-256+x^3\left(x^3-3c_1\right)^4\right)}}}}}-\frac{4\sqrt[3]{2}}{\sqrt[3]{x^3\left(x^3-3c_1\right)^2+\sqrt{x^3\left(-256+x^3\left(x^3\right.}}}}$$

$$y(x) \to \frac{1}{4}\left(\sqrt{2}\sqrt{\frac{8\sqrt[3]{2}x+2^{2/3}\left(x^3\left(x^3-3c_1\right)^2+\sqrt{x^3\left(-256+x^3\left(x^3-3c_1\right)^4\right)}\right)^{2/3}}{x\sqrt[3]{x^3\left(x^3-3c_1\right)^2+\sqrt{x^3\left(-256+x^3\left(x^3-3c_1\right)^4\right)}}}}\right.$$

$$+2\sqrt{-\frac{2\sqrt{2}\left(x^3-3c_1\right)}{\sqrt{\frac{8\sqrt[3]{2}x+2^{2/3}\left(x^3\left(x^3-3c_1\right)^2+\sqrt{x^3\left(-256+x^3\left(x^3-3c_1\right)^4\right)}\right)^{2/3}}{x\sqrt[3]{x^3\left(x^3-3c_1\right)^2+\sqrt{x^3\left(-256+x^3\left(x^3-3c_1\right)^4\right)}}}}}-\frac{4\sqrt[3]{2}}{\sqrt[3]{x^3\left(x^3-3c_1\right)^2+\sqrt{x^3\left(-256+x^3\left(x^3\right.}}}}$$

$$y(x) \to \frac{1}{4}\left(-\sqrt{2}\sqrt{\frac{8\sqrt[3]{2}x+2^{2/3}\left(x^3\left(x^3-3c_1\right)^2+\sqrt{x^3\left(-256+x^3\left(x^3-3c_1\right)^4\right)}\right)^{2/3}}{x\sqrt[3]{x^3\left(x^3-3c_1\right)^2+\sqrt{x^3\left(-256+x^3\left(x^3-3c_1\right)^4\right)}}}}\right.$$

$$-2\sqrt{\frac{2\sqrt{2}\left(x^3-3c_1\right)}{\sqrt{\frac{8\sqrt[3]{2}x+2^{2/3}\left(x^3\left(x^3-3c_1\right)^2+\sqrt{x^3\left(-256+x^3\left(x^3-3c_1\right)^4\right)}\right)^{2/3}}{x\sqrt[3]{x^3\left(x^3-3c_1\right)^2+\sqrt{x^3\left(-256+x^3\left(x^3-3c_1\right)^4\right)}}}}}-\frac{4\sqrt[3]{2}}{\sqrt[3]{x^3\left(x^3-3c_1\right)^2+\sqrt{x^3\left(-256+x^3\left(x^3-\right.}}}}$$

$$y(x)$$

4.16 problem Recognizable Exact Differential equations. Integrating factors. Exercise 10.8, page 90

Internal problem ID [3974]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Exercise 10.8, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class G‘], _rational]`

$$\boxed{y(2x + y^3) - x(2x - y^3)\, y' = 0}$$

✓ Solution by Maple

Time used: 0.062 (sec). Leaf size: 420

```
dsolve((y(x)*(2*x+y(x)^3))-(x*(2*x-y(x)^3))*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{\left(-108x^4+8c_1^3+12\sqrt{81x^4-12c_1^3\,x^2}\right)^{\frac{1}{3}}}{6x} + \frac{2c_1^2}{3x\left(-108x^4+8c_1^3+12\sqrt{81x^4-12c_1^3\,x^2}\right)^{\frac{1}{3}}} + \frac{c_1}{3x}$$

$$y(x) = -\frac{\left(-108x^4+8c_1^3+12\sqrt{81x^4-12c_1^3\,x^2}\right)^{\frac{1}{3}}}{12x} - \frac{c_1^2}{3x\left(-108x^4+8c_1^3+12\sqrt{81x^4-12c_1^3\,x^2}\right)^{\frac{1}{3}}} + \frac{c_1}{3x} - \frac{i\sqrt{3}\left(\frac{\left(-108x^4+8c_1^3+12\sqrt{81x^4-12c_1^3\,x^2}\right)^{\frac{1}{3}}}{6x} - \frac{2c_1^2}{3x\left(-108x^4+8c_1^3+12\sqrt{81x^4-12c_1^3\,x^2}\right)^{\frac{1}{3}}}\right)}{2}$$

$$y(x) = -\frac{\left(-108x^4+8c_1^3+12\sqrt{81x^4-12c_1^3\,x^2}\right)^{\frac{1}{3}}}{12x} - \frac{c_1^2}{3x\left(-108x^4+8c_1^3+12\sqrt{81x^4-12c_1^3\,x^2}\right)^{\frac{1}{3}}} + \frac{c_1}{3x} + \frac{i\sqrt{3}\left(\frac{\left(-108x^4+8c_1^3+12\sqrt{81x^4-12c_1^3\,x^2}\right)^{\frac{1}{3}}}{6x} - \frac{2c_1^2}{3x\left(-108x^4+8c_1^3+12\sqrt{81x^4-12c_1^3\,x^2}\right)^{\frac{1}{3}}}\right)}{2}$$

✓ Solution by Mathematica

Time used: 13.382 (sec). Leaf size: 371

```
DSolve[(y[x]*(2*x+y[x]^3))-(x*(2*x-y[x]^3))*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -\frac{\frac{2\sqrt[3]{2}c_1^2}{\sqrt[3]{27x^4+3\sqrt{81x^8+12c_1^3x^4}+2c_1^3}}+2^{2/3}\sqrt[3]{27x^4+3\sqrt{81x^8+12c_1^3x^4}+2c_1^3}+2c_1}{6x}$$

$$y(x) \to \frac{\frac{2\sqrt[3]{2}(1+i\sqrt{3})c_1^2}{\sqrt[3]{27x^4+3\sqrt{81x^8+12c_1^3x^4}+2c_1^3}}+2^{2/3}(1-i\sqrt{3})\sqrt[3]{27x^4+3\sqrt{81x^8+12c_1^3x^4}+2c_1^3}-4c_1}{12x}$$

$$y(x) \to \frac{\frac{2\sqrt[3]{2}(1-i\sqrt{3})c_1^2}{\sqrt[3]{27x^4+3\sqrt{81x^8+12c_1^3x^4}+2c_1^3}}+2^{2/3}(1+i\sqrt{3})\sqrt[3]{27x^4+3\sqrt{81x^8+12c_1^3x^4}+2c_1^3}-4c_1}{12x}$$

$$y(x) \to 0$$

4.17 problem Recognizable Exact Differential equations. Integrating factors. Exercise 10.9, page 90

Internal problem ID [3975]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Exercise 10.9, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_exact]`

$$\arctan(xy) + \frac{xy - 2xy^2}{x^2y^2 + 1} + \frac{(x^2 - 2x^2y)\,y'}{x^2y^2 + 1} = 0$$

✓ Solution by Maple

Time used: 0.093 (sec). Leaf size: 24

```
dsolve((arctan(x*y(x))+(x*y(x)-2*x*y(x)^2)/(1+x^2*y(x)^2))+((x^2-2*x^2*y(x))/(1+x^2*y(x)^2))*
```

$$y(x) = \frac{\tan\left(\mathrm{RootOf}\left(\_Zx - \ln\left(\tan\left(\_Z\right)^2 + 1\right) + c_1\right)\right)}{x}$$

✓ Solution by Mathematica

Time used: 0.192 (sec). Leaf size: 26

```
DSolve[(ArcTan[x*y[x]]+(x*y[x]-2*x*y[x]^2)/(1+x^2*y[x]^2))+((x^2-2*x^2*y[x])/(1+x^2*y[x]^2))*
```

$$\mathrm{Solve}\left[\log\left(x^2y(x)^2 + 1\right) - x\arctan(xy(x)) = c_1, y(x)\right]$$

4.18 problem Recognizable Exact Differential equations. Integrating factors. Exercise 10.10, page 90

Internal problem ID [3976]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Exercise 10.10, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[‘y=_G(x,y’)‘]`

$$\boxed{e^{x}(x+1)+(y\,e^{y}-e^{x}x)\,y'=0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 20

```
dsolve((exp(x)*(x+1))+(y(x)*exp(y(x))-x*exp(x))*diff(y(x),x)=0,y(x), singsol=all)
```

$$x\,e^{-y(x)+x}+\frac{y(x)^{2}}{2}+c_{1}=0$$

✓ Solution by Mathematica

Time used: 0.305 (sec). Leaf size: 26

```
DSolve[(Exp[x]*(x+1))+(y[x]*Exp[y[x]]-x*Exp[x])*y'[x]==0,y[x],x,IncludeSingularSolutions -> T
```

$$\text{Solve}\left[-\frac{1}{2}y(x)^{2}-xe^{x-y(x)}=c_{1},y(x)\right]$$

4.19 problem Recognizable Exact Differential equations. Integrating factors. Exercise 10.11, page 90

Internal problem ID [3977]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Exercise 10.11, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class D‘], _exact, _rational, [_Abel, ‘2nd typ`

$$\boxed{\frac{xy+1}{y}+\frac{(2y-x)\,y'}{y^2}=0}$$

✓ Solution by Maple

Time used: 0.015 (sec). Leaf size: 20

```
dsolve(((x*y(x)+1)/y(x))+((2*y(x)-x)/y(x)^2)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x)=-\frac{x}{2\,\mathrm{LambertW}\left(-\frac{\mathrm{e}^{\frac{x^2}{4}}c_1x}{2}\right)}$$

✓ Solution by Mathematica

Time used: 4.469 (sec). Leaf size: 37

```
DSolve[((x*y[x]+1)/y[x])+((2*y[x]-x)/y[x]^2)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True
```

$$y(x)\to -\frac{x}{2W\left(-\frac{1}{2}xe^{\frac{1}{4}(x^2-2c_1)}\right)}$$

$$y(x)\to 0$$

4.20 problem Recognizable Exact Differential equations. Integrating factors. Exercise 10.12, page 90

Internal problem ID [3978]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Exercise 10.12, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class A‘], _rational, [_Abel, ‘2nd type‘, ‘cla`

$$y^2 - 3xy - 2x^2 + (xy - x^2)\, y' = 0$$

✓ Solution by Maple

Time used: 0.031 (sec). Leaf size: 59

```
dsolve((y(x)^2-3*x*y(x)-2*x^2)+(x*y(x)-x^2)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{c_1 x^2 - \sqrt{2c_1^2 x^4 + 1}}{c_1 x}$$
$$y(x) = \frac{c_1 x^2 + \sqrt{2c_1^2 x^4 + 1}}{c_1 x}$$

✓ Solution by Mathematica

Time used: 0.682 (sec). Leaf size: 99

```
DSolve[(y[x]^2-3*x*y[x]-2*x^2)+(x*y[x]-x^2)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to x - \frac{\sqrt{2x^4 + e^{2c_1}}}{x}$$
$$y(x) \to x + \frac{\sqrt{2x^4 + e^{2c_1}}}{x}$$
$$y(x) \to x - \frac{\sqrt{2}\sqrt{x^4}}{x}$$
$$y(x) \to \frac{\sqrt{2}\sqrt{x^4}}{x} + x$$

4.21 problem Recognizable Exact Differential equations. Integrating factors. Exercise 10.13, page 90

Internal problem ID [3979]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Exercise 10.13, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_rational, [_Abel, '2nd type', 'class B']]`

$$\boxed{y(y+2x+1)-x(x+2y-1)\,y'=0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 493

```
dsolve((y(x)*(y(x)+2*x+1))-(x*(2*y(x)+x-1))*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{3\,5^{\frac{1}{3}}\left(x\left(\sqrt{5}\,\sqrt{\frac{80c_1x^2-160c_1x+80c_1-x}{c_1}}+20x-20\right)c_1^2\right)^{\frac{1}{3}}}{40c_1} + \frac{3x5^{\frac{2}{3}}}{40\left(x\left(\sqrt{5}\,\sqrt{\frac{80c_1x^2-160c_1x+80c_1-x}{c_1}}+20x-20\right)c_1^2\right)^{\frac{1}{3}}} + x - 1$$

$$y(x) = -\frac{3\,5^{\frac{1}{3}}\left(x\left(\sqrt{5}\,\sqrt{\frac{80c_1x^2-160c_1x+80c_1-x}{c_1}}+20x-20\right)c_1^2\right)^{\frac{1}{3}}}{80c_1} - \frac{3x5^{\frac{2}{3}}}{80\left(x\left(\sqrt{5}\,\sqrt{\frac{80c_1x^2-160c_1x+80c_1-x}{c_1}}+20x-20\right)c_1^2\right)^{\frac{1}{3}}} + x - 1 - \frac{i\sqrt{3}\left(\frac{3\,5^{\frac{1}{3}}\left(x\left(\sqrt{5}\,\sqrt{\frac{80c_1x^2-160c_1x+80c_1-x}{c_1}}+20x-20\right)c_1^2\right)^{\frac{1}{3}}}{40c_1} - \frac{3x5^{\frac{2}{3}}}{40\left(x\left(\sqrt{5}\,\sqrt{\frac{80c_1x^2-160c_1x+80c_1-x}{c_1}}+20x-20\right)c_1^2\right)^{\frac{1}{3}}}\right)}{2}$$

$$y(x) = -\frac{3\,5^{\frac{1}{3}}\left(x\left(\sqrt{5}\,\sqrt{\frac{80c_1x^2-160c_1x+80c_1-x}{c_1}}+20x-20\right)c_1^2\right)^{\frac{1}{3}}}{80c_1} - \frac{3x5^{\frac{2}{3}}}{80\left(x\left(\sqrt{5}\,\sqrt{\frac{80c_1x^2-160c_1x+80c_1-x}{c_1}}+20x-20\right)c_1^2\right)^{\frac{1}{3}}} + x - 1 + \frac{i\sqrt{3}\left(\frac{3\,5^{\frac{1}{3}}\left(x\left(\sqrt{5}\,\sqrt{\frac{80c_1x^2-160c_1x+80c_1-x}{c_1}}+20x-20\right)c_1^2\right)^{\frac{1}{3}}}{40c_1} - \frac{3x5^{\frac{2}{3}}}{40\left(x\left(\sqrt{5}\,\sqrt{\frac{80c_1x^2-160c_1x+80c_1-x}{c_1}}+20x-20\right)c_1^2\right)^{\frac{1}{3}}}\right)}{2}$$

✓ Solution by Mathematica

Time used: 38.706 (sec). Leaf size: 463

```
DSolve[(y[x]*(y[x]+2*x+1))-(x*(2*y[x]+x-1))*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -\frac{\sqrt[3]{2}x}{\sqrt[3]{-27c_1{}^2x^2+\sqrt{108c_1{}^3x^3+(27c_1{}^2x-27c_1{}^2x^2)^2}+27c_1{}^2x}} + \frac{\sqrt[3]{-27c_1{}^2x^2+\sqrt{108c_1{}^3x^3+(27c_1{}^2x-27c_1{}^2x^2)^2}+27c_1{}^2x}}{3\sqrt[3]{2}c_1} + x - 1$$

$$y(x) \to \frac{(1+i\sqrt{3})\,x}{2^{2/3}\sqrt[3]{-27c_1{}^2x^2+\sqrt{108c_1{}^3x^3+(27c_1{}^2x-27c_1{}^2x^2)^2}+27c_1{}^2x}} - \frac{(1-i\sqrt{3})\,\sqrt[3]{-27c_1{}^2x^2+\sqrt{108c_1{}^3x^3+(27c_1{}^2x-27c_1{}^2x^2)^2}+27c_1{}^2x}}{6\sqrt[3]{2}c_1} + x - 1$$

$$y(x) \to \frac{(1-i\sqrt{3})\,x}{2^{2/3}\sqrt[3]{-27c_1{}^2x^2+\sqrt{108c_1{}^3x^3+(27c_1{}^2x-27c_1{}^2x^2)^2}+27c_1{}^2x}} - \frac{(1+i\sqrt{3})\,\sqrt[3]{-27c_1{}^2x^2+\sqrt{108c_1{}^3x^3+(27c_1{}^2x-27c_1{}^2x^2)^2}+27c_1{}^2x}}{6\sqrt[3]{2}c_1} + x - 1$$

$$y(x) \to \text{Indeterminate}$$

$$y(x) \to x - 1$$

4.22 problem Recognizable Exact Differential equations. Integrating factors. Exercise 10.14, page 90

Internal problem ID [3980]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Exercise 10.14, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_rational, [_Abel, ‘2nd type‘, ‘class B‘]]`

$$\boxed{y(2x-y-1)+x(2y-x-1)\,y'=0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 499

```
dsolve((y(x)*(2*x-y(x)-1))+(x*(2*y(x)-x-1))*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{3\,5^{\frac{1}{3}}\left(x\left(\sqrt{5}\,\sqrt{\frac{80c_1x^2+160c_1x+80c_1-x}{c_1}}-20x-20\right)c_1^2\right)^{\frac{1}{3}}}{40c_1} + \frac{3x5^{\frac{2}{3}}}{40\left(x\left(\sqrt{5}\,\sqrt{\frac{80c_1x^2+160c_1x+80c_1-x}{c_1}}-20x-20\right)c_1^2\right)^{\frac{1}{3}}} - x - 1$$

$$y(x) = -\frac{3\,5^{\frac{1}{3}}\left(x\left(\sqrt{5}\,\sqrt{\frac{80c_1x^2+160c_1x+80c_1-x}{c_1}}-20x-20\right)c_1^2\right)^{\frac{1}{3}}}{80c_1} - \frac{3x5^{\frac{2}{3}}}{80\left(x\left(\sqrt{5}\,\sqrt{\frac{80c_1x^2+160c_1x+80c_1-x}{c_1}}-20x-20\right)c_1^2\right)^{\frac{1}{3}}} - x - 1 - \frac{i\sqrt{3}\left(\frac{3\,5^{\frac{1}{3}}\left(x\left(\sqrt{5}\,\sqrt{\frac{80c_1x^2+160c_1x+80c_1-x}{c_1}}-20x-20\right)c_1^2\right)^{\frac{1}{3}}}{40c_1} - \frac{3x5^{\frac{2}{3}}}{40\left(x\left(\sqrt{5}\,\sqrt{\frac{80c_1x^2+160c_1x+80c_1-x}{c_1}}-20x-20\right)c_1^2\right)^{\frac{1}{3}}}\right)}{2}$$

$$y(x) = -\frac{3\,5^{\frac{1}{3}}\left(x\left(\sqrt{5}\,\sqrt{\frac{80c_1x^2+160c_1x+80c_1-x}{c_1}}-20x-20\right)c_1^2\right)^{\frac{1}{3}}}{80c_1} - \frac{3x5^{\frac{2}{3}}}{80\left(x\left(\sqrt{5}\,\sqrt{\frac{80c_1x^2+160c_1x+80c_1-x}{c_1}}-20x-20\right)c_1^2\right)^{\frac{1}{3}}} - x - 1 + \frac{i\sqrt{3}\left(\frac{3\,5^{\frac{1}{3}}\left(x\left(\sqrt{5}\,\sqrt{\frac{80c_1x^2+160c_1x+80c_1-x}{c_1}}-20x-20\right)c_1^2\right)^{\frac{1}{3}}}{40c_1} - \frac{3x5^{\frac{2}{3}}}{40\left(x\left(\sqrt{5}\,\sqrt{\frac{80c_1x^2+160c_1x+80c_1-x}{c_1}}-20x-20\right)c_1^2\right)^{\frac{1}{3}}}\right)}{2}$$

✓ Solution by Mathematica

Time used: 41.115 (sec). Leaf size: 448

```
DSolve[(y[x]*(2*x-y[x]-1))+(x*(2*y[x]-x-1))*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -\frac{\sqrt[3]{\frac{2}{3}}x}{\sqrt[3]{\sqrt{3}\sqrt{c_1{}^3x^2\left(-4x+27c_1(x+1)^2\right)}+9c_1{}^2x(x+1)}} - \frac{\sqrt[3]{\sqrt{3}\sqrt{c_1{}^3x^2\left(-4x+27c_1(x+1)^2\right)}+9c_1{}^2x(x+1)}}{\sqrt[3]{2}3^{2/3}c_1} - x - 1$$

$$y(x) \to \frac{\left(1-i\sqrt{3}\right)\sqrt[3]{\sqrt{3}\sqrt{c_1{}^3x^2\left(-4x+27c_1(x+1)^2\right)}+9c_1{}^2x(x+1)}}{2\sqrt[3]{2}3^{2/3}c_1} + \frac{x+i\sqrt{3}x}{2^{2/3}\sqrt[3]{3}\sqrt[3]{\sqrt{3}\sqrt{c_1{}^3x^2\left(-4x+27c_1(x+1)^2\right)}+9c_1{}^2x(x+1)}} - x - 1$$

$$y(x) \to \frac{\left(1+i\sqrt{3}\right)\sqrt[3]{\sqrt{3}\sqrt{c_1{}^3x^2\left(-4x+27c_1(x+1)^2\right)}+9c_1{}^2x(x+1)}}{2\sqrt[3]{2}3^{2/3}c_1} + \frac{x-i\sqrt{3}x}{2^{2/3}\sqrt[3]{3}\sqrt[3]{\sqrt{3}\sqrt{c_1{}^3x^2\left(-4x+27c_1(x+1)^2\right)}+9c_1{}^2x(x+1)}} - x - 1$$

$$y(x) \to \text{Indeterminate}$$

$$y(x) \to -x - 1$$

4.23 problem Recognizable Exact Differential equations. Integrating factors. Exercise 10.15, page 90

Internal problem ID [3981]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Exercise 10.15, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class G‘], _exact, _rational, [_Abel, ‘2nd typ`

$$\boxed{y^2 + 12x^2y + (2xy + 4x^3)\, y' = 0}$$

✓ Solution by Maple

Time used: 0.047 (sec). Leaf size: 50

```
dsolve((y(x)^2+12*x^2*y(x))+(2*x*y(x)+4*x^3)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{-2x^3 + \sqrt{4x^6 + c_1 x}}{x}$$
$$y(x) = -\frac{2x^3 + \sqrt{4x^6 + c_1 x}}{x}$$

✓ Solution by Mathematica

Time used: 0.451 (sec). Leaf size: 58

```
DSolve[(y[x]^2+12*x^2*y[x])+(2*x*y[x]+4*x^3)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True
```

$$y(x) \to -\frac{2x^3 + \sqrt{x(4x^5 + c_1)}}{x}$$
$$y(x) \to \frac{-2x^3 + \sqrt{x(4x^5 + c_1)}}{x}$$

4.24 problem Recognizable Exact Differential equations. Integrating factors. Exercise 10.16, page 90

Internal problem ID [3982]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Exercise 10.16, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type **`[[_homogeneous, ‘class A‘], _rational, [_Abel, ‘2nd type‘, ‘cla`**

$$\boxed{3(y+x)^2 + x(3y+2x)\,y' = 0}$$

✓ Solution by Maple

Time used: 0.031 (sec). Leaf size: 63

```
dsolve((3*(y(x)+x)^2)+(x*(3*y(x)+2*x))*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{-\frac{2c_1x^2}{3} - \frac{\sqrt{-2c_1^2x^4+6}}{6}}{c_1x}$$

$$y(x) = \frac{-\frac{2c_1x^2}{3} + \frac{\sqrt{-2c_1^2x^4+6}}{6}}{c_1x}$$

✓ Solution by Mathematica

Time used: 1.774 (sec). Leaf size: 135

```
DSolve[(3*(y[x]+x)^2)+(x*(3*y[x]+2*x))*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -\frac{4x^2 + \sqrt{-2x^4 + 6e^{4c_1}}}{6x}$$

$$y(x) \to \frac{-4x^2 + \sqrt{-2x^4 + 6e^{4c_1}}}{6x}$$

$$y(x) \to -\frac{\sqrt{2}\sqrt{-x^4} + 4x^2}{6x}$$

$$y(x) \to \frac{\sqrt{2}\sqrt{-x^4} - 4x^2}{6x}$$

4.25 problem Recognizable Exact Differential equations. Integrating factors. Exercise 10.17, page 90

Internal problem ID [3983]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Exercise 10.17, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_rational]`

$$\boxed{y - (x^2 + y^2 + x)\, y' = 0}$$

✓ Solution by Maple

Time used: 0.047 (sec). Leaf size: 30

```
dsolve((y(x))-(y(x)^2+x^2+x)*diff(y(x),x)=0,y(x), singsol=all)
```

$$c_1 + \frac{e^{-2iy(x)}(ix + y(x))}{2iy(x) + 2x} = 0$$

✓ Solution by Mathematica

Time used: 0.107 (sec). Leaf size: 18

```
DSolve[(y[x])-(y[x]^2+x^2+x)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$\text{Solve}\left[y(x) - \arctan\left(\frac{x}{y(x)}\right) = c_1, y(x)\right]$$

4.26 problem Recognizable Exact Differential equations. Integrating factors. Exercise 10.18, page 90

Internal problem ID [3984]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Exercise 10.18, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_exact, _rational, [_1st_order, '_with_symmetry_[F(x)*G(y),0]'`

$$
\boxed{2xy + \left(x^2 + y^2 + a\right) y' = 0}
$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 470

```
dsolve((2*x*y(x))+(x^2+y(x)^2+a)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{\left(-12c_1+4\sqrt{4x^6+12a\,x^4+12a^2x^2+4a^3+9c_1^2}\right)^{\frac{1}{3}}}{2} - \frac{2(x^2+a)}{\left(-12c_1+4\sqrt{4x^6+12a\,x^4+12a^2x^2+4a^3+9c_1^2}\right)^{\frac{1}{3}}}$$

$$y(x) = -\frac{\left(-12c_1+4\sqrt{4x^6+12a\,x^4+12a^2x^2+4a^3+9c_1^2}\right)^{\frac{1}{3}}}{4} + \frac{x^2+a}{\left(-12c_1+4\sqrt{4x^6+12a\,x^4+12a^2x^2+4a^3+9c_1^2}\right)^{\frac{1}{3}}} - \frac{i\sqrt{3}\left(\frac{\left(-12c_1+4\sqrt{4x^6+12a\,x^4+12a^2x^2+4a^3+9c_1^2}\right)^{\frac{1}{3}}}{2} + \frac{2x^2+2a}{\left(-12c_1+4\sqrt{4x^6+12a\,x^4+12a^2x^2+4a^3+9c_1^2}\right)^{\frac{1}{3}}}\right)}{2}$$

$$y(x) = -\frac{\left(-12c_1+4\sqrt{4x^6+12a\,x^4+12a^2x^2+4a^3+9c_1^2}\right)^{\frac{1}{3}}}{4} + \frac{x^2+a}{\left(-12c_1+4\sqrt{4x^6+12a\,x^4+12a^2x^2+4a^3+9c_1^2}\right)^{\frac{1}{3}}} + \frac{i\sqrt{3}\left(\frac{\left(-12c_1+4\sqrt{4x^6+12a\,x^4+12a^2x^2+4a^3+9c_1^2}\right)^{\frac{1}{3}}}{2} + \frac{2x^2+2a}{\left(-12c_1+4\sqrt{4x^6+12a\,x^4+12a^2x^2+4a^3+9c_1^2}\right)^{\frac{1}{3}}}\right)}{2}$$

✓ Solution by Mathematica

Time used: 4.365 (sec). Leaf size: 299

```
DSolve[(2*x*y[x])+(x^2+y[x]^2+a)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{\sqrt[3]{2}\left(\sqrt{4\left(a+x^2\right)^3+9c_1{}^2}+3c_1\right)^{2/3}-2a-2x^2}{2^{2/3}\sqrt[3]{\sqrt{4\left(a+x^2\right)^3+9c_1{}^2}+3c_1}}$$

$$y(x) \to \frac{\left(1+i\sqrt{3}\right)\left(a+x^2\right)}{2^{2/3}\sqrt[3]{\sqrt{4\left(a+x^2\right)^3+9c_1{}^2}+3c_1}}+\frac{i\left(\sqrt{3}+i\right)\sqrt[3]{\sqrt{4\left(a+x^2\right)^3+9c_1{}^2}+3c_1}}{2\sqrt[3]{2}}$$

$$y(x) \to \frac{\left(1-i\sqrt{3}\right)\left(a+x^2\right)}{2^{2/3}\sqrt[3]{\sqrt{4\left(a+x^2\right)^3+9c_1{}^2}+3c_1}}-\frac{i\left(\sqrt{3}-i\right)\sqrt[3]{\sqrt{4\left(a+x^2\right)^3+9c_1{}^2}+3c_1}}{2\sqrt[3]{2}}$$

$$y(x) \to 0$$

4.27 problem Recognizable Exact Differential equations. Integrating factors. Exercise 10.19, page 90

Internal problem ID [3985]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 10
Problem number: Recognizable Exact Differential equations. Integrating factors. Exercise 10.19, page 90.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_exact, _rational]`

$$\boxed{2xy + x^2 + b + \left(x^2 + y^2 + a\right) y' = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 810

```
dsolve((2*x*y(x)+x^2+b)+(y(x)^2+x^2+a)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{\left(-4x^3-12xb-12c_1+4\sqrt{5x^6+12a\,x^4+6b\,x^4+12a^2x^2+9b^2x^2+6c_1x^3+4a^3+18bc_1x+9c_1^2}\right)^{\frac{1}{3}}}{2} - \frac{2(x^2+a)}{\left(-4x^3-12xb-12c_1+4\sqrt{5x^6+12a\,x^4+6b\,x^4+12a^2x^2+9b^2x^2+6c_1x^3+4a^3+18bc_1x+9c_1^2}\right)^{\frac{1}{3}}}$$

$$y(x) = -\frac{\left(-4x^3-12xb-12c_1+4\sqrt{5x^6+12a\,x^4+6b\,x^4+12a^2x^2+9b^2x^2+6c_1x^3+4a^3+18bc_1x+9c_1^2}\right)^{\frac{1}{3}}}{4} + \frac{x^2+a}{\left(-4x^3-12xb-12c_1+4\sqrt{5x^6+12a\,x^4+6b\,x^4+12a^2x^2+9b^2x^2+6c_1x^3+4a^3+18bc_1x+9c_1^2}\right)^{\frac{1}{3}}} - \frac{i\sqrt{3}\left(\frac{\left(-4x^3-12xb-12c_1+4\sqrt{5x^6+12a\,x^4+6b\,x^4+12a^2x^2+9b^2x^2+6c_1x^3+4a^3+18bc_1x+9c_1^2}\right)^{\frac{1}{3}}}{2} + \frac{\cdots}{\left(-4x^3-12xb-12c_1+4\sqrt{5x^6+12a\,x \cdots}\right.}\right.}{2}$$

$$y(x) = -\frac{\left(-4x^3-12xb-12c_1+4\sqrt{5x^6+12a\,x^4+6b\,x^4+12a^2x^2+9b^2x^2+6c_1x^3+4a^3+18bc_1x+9c_1^2}\right)^{\frac{1}{3}}}{4} + \frac{x^2+a}{\left(-4x^3-12xb-12c_1+4\sqrt{5x^6+12a\,x^4+6b\,x^4+12a^2x^2+9b^2x^2+6c_1x^3+4a^3+18bc_1x+9c_1^2}\right)^{\frac{1}{3}}} + \frac{i\sqrt{3}\left(\frac{\left(-4x^3-12xb-12c_1+4\sqrt{5x^6+12a\,x^4+6b\,x^4+12a^2x^2+9b^2x^2+6c_1x^3+4a^3+18bc_1x+9c_1^2}\right)^{\frac{1}{3}}}{2} + \frac{\cdots}{\left(-4x^3-12xb-12c_1+4\sqrt{5x^6+12a\,x \cdots}\right.}\right.}{2}$$

✓ Solution by Mathematica

Time used: 6.645 (sec). Leaf size: 396

```
DSolve[(2*x*y[x]+x^2+b)+(y[x]^2+x^2+a)*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{\sqrt[3]{2}\left(\sqrt{4\left(a+x^2\right)^3+\left(3bx+x^3-3c_1\right)^2}-3bx-x^3+3c_1\right)^{2/3}-2a-2x^2}{2^{2/3}\sqrt[3]{\sqrt{4\left(a+x^2\right)^3+\left(3bx+x^3-3c_1\right)^2}-3bx-x^3+3c_1}}$$

$$y(x) \to \frac{\left(1+i\sqrt{3}\right)\left(a+x^2\right)}{2^{2/3}\sqrt[3]{\sqrt{4\left(a+x^2\right)^3+\left(3bx+x^3-3c_1\right)^2}-3bx-x^3+3c_1}} + \frac{i\left(\sqrt{3}+i\right)\sqrt[3]{\sqrt{4\left(a+x^2\right)^3+\left(3bx+x^3-3c_1\right)^2}-3bx-x^3+3c_1}}{2\sqrt[3]{2}}$$

$$y(x) \to \frac{\left(1-i\sqrt{3}\right)\left(a+x^2\right)}{2^{2/3}\sqrt[3]{\sqrt{4\left(a+x^2\right)^3+\left(3bx+x^3-3c_1\right)^2}-3bx-x^3+3c_1}} - \frac{i\left(\sqrt{3}-i\right)\sqrt[3]{\sqrt{4\left(a+x^2\right)^3+\left(3bx+x^3-3c_1\right)^2}-3bx-x^3+3c_1}}{2\sqrt[3]{2}}$$

5 Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations

5.1 problem Exercise 11.1, page 97

Internal problem ID [3986]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.1, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_linear]`

$$\boxed{y'x + y - x^3 = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 15

```
dsolve(x*diff(y(x),x)+y(x)=x^3,y(x), singsol=all)
```

$$y(x) = \frac{\frac{x^4}{4} + c_1}{x}$$

✓ Solution by Mathematica

Time used: 0.026 (sec). Leaf size: 19

```
DSolve[x*y'[x]+y[x]==x^3,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{x^3}{4} + \frac{c_1}{x}$$

5.2 problem Exercise 11.2, page 97

Internal problem ID [3987]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.2, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_quadrature]`

$$\boxed{y' + ya - b = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 17

```
dsolve(diff(y(x),x)+a*y(x)=b,y(x), singsol=all)
```

$$y(x) = \frac{b}{a} + \mathrm{e}^{-ax}c_1$$

✓ Solution by Mathematica

Time used: 0.037 (sec). Leaf size: 29

```
DSolve[y'[x]+a*y[x]==b,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{b}{a} + c_1 e^{-ax}$$
$$y(x) \to \frac{b}{a}$$

5.3 problem Exercise 11.3, page 97

Internal problem ID [3988]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.3, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_Bernoulli]`

$$\boxed{y'x + y - y^2 \ln(x) = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 13

```
dsolve(x*diff(y(x),x)+y(x)=y(x)^2*ln(x),y(x), singsol=all)
```

$$y(x) = \frac{1}{1 + c_1 x + \ln(x)}$$

✓ Solution by Mathematica

Time used: 0.157 (sec). Leaf size: 20

```
DSolve[x*y'[x]+y[x]==y[x]^2*Log[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{\log(x) + c_1 x + 1}$$
$$y(x) \to 0$$

5.4 problem Exercise 11.4, page 97

Internal problem ID [3989]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.4, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_linear]`

$$\boxed{x' + 2yx - e^{-y^2} = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 14

```
dsolve(diff(x(y),y)+2*y*x(y)=exp(-y^2),x(y), singsol=all)
```

$$x(y) = (y + c_1) e^{-y^2}$$

✓ Solution by Mathematica

Time used: 0.055 (sec). Leaf size: 17

```
DSolve[x'[y]+2*y*x[y]==Exp[-y^2],x[y],y,IncludeSingularSolutions -> True]
```

$$x(y) \to e^{-y^2}(y + c_1)$$

5.5 problem Exercise 11.5, page 97

Internal problem ID [3990]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.5, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_linear]`

$$\boxed{r' - (r + e^{-\theta}) \tan(\theta) = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 26

```
dsolve(diff(r(theta),theta)=(r(theta)+exp(-theta))*tan(theta),r(theta), singsol=all)
```

$$r(\theta) = \frac{c_1}{\cos(\theta)} - \frac{e^{-\theta}(\cos(\theta) + \sin(\theta))}{2\cos(\theta)}$$

✓ Solution by Mathematica

Time used: 0.094 (sec). Leaf size: 24

```
DSolve[r'[\[Theta]]==(r[\[Theta]]+Exp[-\[Theta]])*Tan[\[Theta]],r[\[Theta]],\[Theta],IncludeS
```

$$r(\theta) \to -\frac{1}{2}e^{-\theta}(\tan(\theta) + 1) + c_1 \sec(\theta)$$

5.6 problem Exercise 11.6, page 97

Internal problem ID [3991]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.6, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_linear]`

$$\boxed{y' - \frac{2xy}{x^2+1} - 1 = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 14

```
dsolve(diff(y(x),x)-(2*x*y(x))/(x^2+1)=1,y(x), singsol=all)
```

$$y(x) = (\arctan(x) + c_1)\left(x^2+1\right)$$

✓ Solution by Mathematica

Time used: 0.034 (sec). Leaf size: 16

```
DSolve[y'[x]-2*x*y[x]/(x^2+1)==1,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \left(x^2+1\right)(\arctan(x) + c_1)$$

5.7 problem Exercise 11.7, page 97

Internal problem ID [3992]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.7, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_Bernoulli]`

$$\boxed{y' + y - y^3 x = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 39

```
dsolve(diff(y(x),x)+y(x)=x*y(x)^3,y(x), singsol=all)
```

$$y(x) = -\frac{2}{\sqrt{2 + 4c_1 e^{2x} + 4x}}$$
$$y(x) = \frac{2}{\sqrt{2 + 4c_1 e^{2x} + 4x}}$$

✓ Solution by Mathematica

Time used: 2.855 (sec). Leaf size: 50

```
DSolve[y'[x]+y[x]==x*y[x]^3,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -\frac{1}{\sqrt{x + c_1 e^{2x} + \frac{1}{2}}}$$
$$y(x) \to \frac{1}{\sqrt{x + c_1 e^{2x} + \frac{1}{2}}}$$
$$y(x) \to 0$$

5.8 problem Exercise 11.8, page 97

Internal problem ID [3993]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.8, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_rational, _Bernoulli]`

$$\boxed{\left(-x^{3}+1\right) y'-2(x+1)\, y-y^{\frac{5}{2}}=0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 45

```
dsolve((1-x^3)*diff(y(x),x)-2*(1+x)*y(x)=y(x)^(5/2),y(x), singsol=all)
```

$$-\frac{c_{1}}{\frac{x^{2}}{(x-1)^{2}}+\frac{x}{(x-1)^{2}}+\frac{1}{(x-1)^{2}}}+\frac{1}{y\left(x\right)^{\frac{3}{2}}}+\frac{3}{4\left(x^{2}+x+1\right)}=0$$

✓ Solution by Mathematica

Time used: 3.048 (sec). Leaf size: 41

```
DSolve[(1-x^3)*y'[x]-2*(1+x)*y[x]==y[x]^(5/2),y[x],x,IncludeSingularSolutions -> True]
```

$$y(x)\to \frac{2\sqrt[3]{2}}{\left(\frac{-3+4c_{1}(x-1)^{2}}{x^{2}+x+1}\right)^{2/3}}$$

$$y(x)\to 0$$

5.9 problem Exercise 11.9, page 97

Internal problem ID [3994]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.9, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_linear]`

$$\boxed{\tan(\theta) r' - r - \tan(\theta)^2 = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 15

```
dsolve(tan(theta)*diff(r(theta),theta)-r(theta)=tan(theta)^2,r(theta), singsol=all)
```

$$r(\theta) = (\ln(\sec(\theta) + \tan(\theta)) + c_1)\sin(\theta)$$

✓ Solution by Mathematica

Time used: 0.05 (sec). Leaf size: 14

```
DSolve[Tan[\[Theta]]*r'[\[Theta]]-r[\[Theta]]==Tan[\[Theta]]^2,r[\[Theta]],\[Theta],IncludeSi
```

$$r(\theta) \to \sin(\theta)(\operatorname{arctanh}(\sin(\theta)) + c_1)$$

5.10 problem Exercise 11.11, page 97

Internal problem ID [3995]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.11, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_linear, ‘class A‘]]`

$$\boxed{y' + 2y - 3\,\mathrm{e}^{-2x} = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 14

```
dsolve(diff(y(x),x)+2*y(x)=3*exp(-2*x),y(x), singsol=all)
```

$$y(x) = (3x + c_1)\,\mathrm{e}^{-2x}$$

✓ Solution by Mathematica

Time used: 0.049 (sec). Leaf size: 17

```
DSolve[y'[x]+2*y[x]==3*Exp[-2*x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^{-2x}(3x + c_1)$$

5.11 problem Exercise 11.12, page 97

Internal problem ID [3996]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.12, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_linear, ‘class A‘]]`

$$\boxed{y' + 2y - \frac{3\,\mathrm{e}^{-2x}}{4} = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 14

```
dsolve(diff(y(x),x)+2*y(x)=3/4*exp(-2*x),y(x), singsol=all)
```

$$y(x) = \left(\frac{3x}{4} + c_1\right)\mathrm{e}^{-2x}$$

✓ Solution by Mathematica

Time used: 0.051 (sec). Leaf size: 22

```
DSolve[y'[x]+2*y[x]==3/4*Exp[-2*x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{4}e^{-2x}(3x + 4c_1)$$

5.12 problem Exercise 11.11, page 97

Internal problem ID [3997]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.11, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_linear, ‘class A‘]]`

$$\boxed{y' + 2y - \sin(x) = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 19

```
dsolve(diff(y(x),x)+2*y(x)=sin(x),y(x), singsol=all)
```

$$y(x) = -\frac{\cos(x)}{5} + \frac{2\sin(x)}{5} + c_1 e^{-2x}$$

✓ Solution by Mathematica

Time used: 0.041 (sec). Leaf size: 26

```
DSolve[y'[x]+2*y[x]==Sin[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{2\sin(x)}{5} - \frac{\cos(x)}{5} + c_1 e^{-2x}$$

5.13 problem Exercise 11.14, page 97

Internal problem ID [3998]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.14, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_linear]`

$$\boxed{y' + y\cos(x) - e^{2x} = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 21

```
dsolve(diff(y(x),x)+y(x)*cos(x)=exp(2*x),y(x), singsol=all)
```

$$y(x) = \left(\int e^{2x+\sin(x)}dx + c_1\right)e^{-\sin(x)}$$

✓ Solution by Mathematica

Time used: 0.747 (sec). Leaf size: 32

```
DSolve[y'[x]+y[x]*Cos[x]==Exp[2*x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^{-\sin(x)}\left(\int_1^x e^{2K[1]+\sin(K[1])}dK[1] + c_1\right)$$

5.14 problem Exercise 11.15, page 97

Internal problem ID [3999]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.15, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_linear]`

$$\boxed{y' + y\cos(x) - \frac{\sin(2x)}{2} = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 15

```
dsolve(diff(y(x),x)+y(x)*cos(x)=1/2*sin(2*x),y(x), singsol=all)
```

$$y(x) = \sin(x) - 1 + e^{-\sin(x)} c_1$$

✓ Solution by Mathematica

Time used: 0.049 (sec). Leaf size: 18

```
DSolve[y'[x]+y[x]*Cos[x]==1/2*Sin[2*x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \sin(x) + c_1 e^{-\sin(x)} - 1$$

5.15 problem Exercise 11.16, page 97

Internal problem ID [4000]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.16, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_linear]`

$$\boxed{y'x + y - \sin(x)\, x = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 17

```
dsolve(x*diff(y(x),x)+y(x)=x*sin(x),y(x), singsol=all)
```

$$y(x) = \frac{-x\cos(x) + \sin(x) + c_1}{x}$$

✓ Solution by Mathematica

Time used: 0.035 (sec). Leaf size: 19

```
DSolve[x*y'[x]+y[x]==x*Sin[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{\sin(x) - x\cos(x) + c_1}{x}$$

5.16 problem Exercise 11.17, page 97

Internal problem ID [4001]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.17, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_linear]`

$$\boxed{-y + y'x - \sin(x)\, x^2 = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 12

```
dsolve(x*diff(y(x),x)-y(x)=x^2*sin(x),y(x), singsol=all)
```

$$y(x) = (-\cos(x) + c_1)\, x$$

✓ Solution by Mathematica

Time used: 0.034 (sec). Leaf size: 14

```
DSolve[x*y'[x]-y[x]==x^2*Sin[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to x(-\cos(x) + c_1)$$

5.17 problem Exercise 11.18, page 97

Internal problem ID [4002]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.18, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class D‘], _rational, _Bernoulli]`

$$\boxed{y'x + xy^2 - y = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 16

```
dsolve(x*diff(y(x),x)+x*y(x)^2-y(x)=0,y(x), singsol=all)
```

$$y(x) = \frac{2x}{x^2 + 2c_1}$$

✓ Solution by Mathematica

Time used: 0.15 (sec). Leaf size: 23

```
DSolve[x*y'[x]+x*y[x]^2-y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{2x}{x^2 + 2c_1}$$
$$y(x) \to 0$$

5.18 problem Exercise 11.19, page 97

Internal problem ID [4003]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.19, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_Bernoulli]`

$$\boxed{y'x - y(2\ln(x)\, y - 1) = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 15

```
dsolve(x*diff(y(x),x)-y(x)*(2*y(x)*ln(x)-1)=0,y(x), singsol=all)
```

$$y(x) = \frac{1}{2 + c_1 x + 2\ln(x)}$$

✓ Solution by Mathematica

Time used: 0.138 (sec). Leaf size: 22

```
DSolve[x*y'[x]-y[x]*(2*y[x]*Log[x]-1)==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{2\log(x) + c_1 x + 2}$$

$$y(x) \to 0$$

5.19 problem Exercise 11.20, page 97

Internal problem ID [4004]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.20, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class D‘], _rational, _Bernoulli]`

$$\boxed{x^2(x-1)\,y'-y^2-x(x-2)\,y=0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 18

```
dsolve(x^2*(x-1)*diff(y(x),x)-y(x)^2-x*(x-2)*y(x)=0,y(x), singsol=all)
```

$$y(x)=\frac{x^2}{c_1x-c_1+1}$$

✓ Solution by Mathematica

Time used: 0.191 (sec). Leaf size: 25

```
DSolve[x^2*(x-1)*y'[x]-y[x]^2-x*(x-2)*y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x)\to\frac{x^2}{c_1(-x)+1+c_1}$$
$$y(x)\to 0$$

5.20 problem Exercise 11.21, page 97

Internal problem ID [4005]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.21, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_linear, 'class A']]`

$$\boxed{y' - y - e^x = 0}$$

With initial conditions

$$[y(0) = 1]$$

✓ Solution by Maple

Time used: 0.015 (sec). Leaf size: 10

```
dsolve([diff(y(x),x)-y(x)=exp(x),y(0) = 1],y(x), singsol=all)
```

$$y(x) = e^x(x + 1)$$

✓ Solution by Mathematica

Time used: 0.039 (sec). Leaf size: 12

```
DSolve[{y'[x]-y[x]==Exp[x],{y[0]==1}},y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^x(x + 1)$$

5.21 problem Exercise 11.22, page 97

Internal problem ID [4006]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.22, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_separable]`

$$\boxed{y' + \frac{y}{x} - \frac{y^2}{x} = 0}$$

With initial conditions

$$[y(-1) = 1]$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 5

```
dsolve([diff(y(x),x)+y(x)/x=y(x)^2/x,y(-1) = 1],y(x), singsol=all)
```

$$y(x) = 1$$

✓ Solution by Mathematica

Time used: 0.001 (sec). Leaf size: 6

```
DSolve[{y'[x]+y[x]/x==y[x]^2/x,{y[-1]==1}},y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to 1$$

5.22 problem Exercise 11.23, page 97

Internal problem ID [4007]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.23, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_Bernoulli]`

$$\boxed{2\cos(x) y' - y \sin(x) + y^3 = 0}$$

With initial conditions

$$[y(0) = 1]$$

✓ Solution by Maple

Time used: 0.36 (sec). Leaf size: 33

```
dsolve([2*cos(x)*diff(y(x),x)=y(x)*sin(x)-y(x)^3,y(0) = 1],y(x), singsol=all)
```

$$y(x) = \frac{\sqrt{\left(2\cos(x)^2 - 1\right)\left(\cos(x) - \sin(x)\right)}}{2\cos(x)^2 - 1}$$

✓ Solution by Mathematica

Time used: 0.375 (sec). Leaf size: 14

```
DSolve[{2*Cos[x]*y'[x]==y[x]*Sin[x]-y[x]^3,{y[0]==1}},y[x],x,IncludeSingularSolutions -> True
```

$$y(x) \to \frac{1}{\sqrt{\sin(x) + \cos(x)}}$$

5.23 problem Exercise 11.24, page 97

Internal problem ID [4008]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.24, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_1st_order, '_with_symmetry_[F(x)*G(y),0]']]`

$$\boxed{(x-\cos(y))\,y'+\tan(y)=0}$$

With initial conditions

$$\left[y(1)=\frac{\pi}{6}\right]$$

✓ Solution by Maple

Time used: 1.235 (sec). Leaf size: 29

```
dsolve([(x-cos(y(x)))*diff(y(x),x)+tan(y(x))=0,y(1) = 1/6*Pi],y(x), singsol=all)
```

$$y(x)=\operatorname{RootOf}\left(24x\sin(\_Z)+3\sqrt{3}-6\sin(2\_Z)+2\pi-12\_Z-12\right)$$

✓ Solution by Mathematica

Time used: 0.221 (sec). Leaf size: 45

```
DSolve[{(x-Cos[y[x]])*y'[x]+Tan[y[x]]==0,{y[1]==Pi/6}},y[x],x,IncludeSingularSolutions -> Tru
```

$$\text{Solve}\left[x=\frac{1}{24}\left(12-3\sqrt{3}-2\pi\right)\csc(y(x))+\left(\frac{y(x)}{2}+\frac{1}{4}\sin(2y(x))\right)\csc(y(x)),y(x)\right]$$

5.24 problem Exercise 11.26, page 97

Internal problem ID [4009]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.26, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_rational, _Riccati]`

$$\boxed{y' - x^3 - \frac{2y}{x} + \frac{y^2}{x} = 0}$$

✓ Solution by Maple

Time used: 0.015 (sec). Leaf size: 19

```
dsolve(diff(y(x),x)=x^3+2/x*y(x)-1/x*y(x)^2,y(x), singsol=all)
```

$$y(x) = i \tan\left(-\frac{i x^2}{2} + c_1\right) x^2$$

✓ Solution by Mathematica

Time used: 0.163 (sec). Leaf size: 75

```
DSolve[y'[x]==x^3+2/x*y[x]-1/x*y[x]^2,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{x^2\left(i\cosh\left(\frac{x^2}{2}\right) + c_1\sinh\left(\frac{x^2}{2}\right)\right)}{i\sinh\left(\frac{x^2}{2}\right) + c_1\cosh\left(\frac{x^2}{2}\right)}$$

$$y(x) \to x^2 \tanh\left(\frac{x^2}{2}\right)$$

5.25 problem Exercise 11.27, page 97

Internal problem ID [4010]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.27, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_Riccati]`

$$\boxed{y' - 2\sec(x)\tan(x) + \sin(x)\, y^2 = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 41

```
dsolve(diff(y(x),x)=2*tan(x)*sec(x)-y(x)^2*sin(x),y(x), singsol=all)
```

$$y(x) = \frac{\sec(x)\tan(x)}{\sin(x)\left(c_1 \cos(x)^2 + \sec(x)\right)} - \frac{2c_1 \cos(x)}{c_1 \cos(x)^2 + \sec(x)}$$

✓ Solution by Mathematica

Time used: 0.534 (sec). Leaf size: 29

```
DSolve[y'[x]==2*Tan[x]*Sec[x]-y[x]^2*Sin[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \sec(x) - \frac{3\cos^2(x)}{\cos^3(x) + c_1}$$

$$y(x) \to \sec(x)$$

5.26 problem Exercise 11.28, page 97

Internal problem ID [4011]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.28, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class G‘], _rational, _Riccati]`

$$\boxed{y' - \frac{1}{x^2} + \frac{y}{x} + y^2 = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 16

```
dsolve(diff(y(x),x)=1/x^2-y(x)/x-y(x)^2,y(x), singsol=all)
```

$$y(x) = -\frac{\tanh\left(-\ln\left(x\right) + c_1\right)}{x}$$

✓ Solution by Mathematica

Time used: 1.185 (sec). Leaf size: 61

```
DSolve[y'[x]==1/x^2-y[x]/x-y[x]^2,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{i\tan(c_1 - i\log(x))}{x}$$
$$y(x) \to \frac{x^2 - e^{2i\text{Interval}[\{0,\pi\}]}}{x^3 + xe^{2i\text{Interval}[\{0,\pi\}]}}$$

5.27 problem Exercise 11.29, page 97

Internal problem ID [4012]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 11, Bernoulli Equations
Problem number: Exercise 11.29, page 97.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class A‘], _rational, _Riccati]`

$$\boxed{y' - 1 - \frac{y}{x} + \frac{y^2}{x^2} = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 11

```
dsolve(diff(y(x),x)=1+y(x)/x-y(x)^2/x^2,y(x), singsol=all)
```

$$y(x) = \tanh\left(\ln\left(x\right) + c_1\right) x$$

✓ Solution by Mathematica

Time used: 0.526 (sec). Leaf size: 38

```
DSolve[y'[x]==1+y[x]/x-y[x]^2/x^2,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -x + \frac{2x^3}{x^2 + e^{2c_1}}$$
$$y(x) \to -x$$
$$y(x) \to x$$

6 Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods

6.1 problem Exercise 12.1, page 103

Internal problem ID [4013]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.1, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_Bernoulli]`

$$\boxed{2xyy' + y^2(x+1) - e^x = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 59

```
dsolve(2*x*y(x)*diff(y(x),x)+(1+x)*y(x)^2=exp(x),y(x), singsol=all)
```

$$y(x) = -\frac{e^{-x}\sqrt{2}\,\sqrt{e^x x\,(e^{2x} + 2c_1)}}{2x}$$
$$y(x) = \frac{e^{-x}\sqrt{2}\,\sqrt{e^x x\,(e^{2x} + 2c_1)}}{2x}$$

✓ Solution by Mathematica

Time used: 7.339 (sec). Leaf size: 66

```
DSolve[2*x*y[x]*y'[x]+(1+x)*y[x]^2==Exp[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -\frac{\sqrt{e^x + 2c_1 e^{-x}}}{\sqrt{2}\sqrt{x}}$$
$$y(x) \to \frac{\sqrt{e^x + 2c_1 e^{-x}}}{\sqrt{2}\sqrt{x}}$$

6.2 problem Exercise 12.2, page 103

Internal problem ID [4014]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.2, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[‘y=_G(x,y’)‘]`

$$\boxed{\cos(y)\, y' + \sin(y) - x^2 = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 29

```
dsolve(cos(y(x))*diff(y(x),x)+sin(y(x))=x^2,y(x), singsol=all)
```

$$y(x) = \arcsin\left(\left(\mathrm{e}^x x^2 - 2\,\mathrm{e}^x x + 2\,\mathrm{e}^x - c_1\right)\mathrm{e}^{-x}\right)$$

✓ Solution by Mathematica

Time used: 14.177 (sec). Leaf size: 22

```
DSolve[Cos[y[x]]*y'[x]+Sin[y[x]]==x^2,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \arcsin\left((x-2)x - 2c_1 e^{-x} + 2\right)$$

6.3 problem Exercise 12.3, page 103

Internal problem ID [4015]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.3, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_1st_order, _with_linear_symmetries]]`

$$\boxed{(x+1)\, y' - 1 - y - (x+1)\sqrt{1+y} = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 160

```
dsolve((x+1)*diff(y(x),x)-(y(x)+1)=(x+1)*sqrt(y(x)+1),y(x), singsol=all)
```

$$\begin{aligned}
&\frac{\sqrt{y(x)+1}\, x}{(-x^2-2x+y(x))\left(\sqrt{y(x)+1}-1-x\right)} \\
&+\frac{2x}{(-x^2-2x+y(x))\left(\sqrt{y(x)+1}-1-x\right)} \\
&+\frac{x^2}{(-x^2-2x+y(x))\left(\sqrt{y(x)+1}-1-x\right)} \\
&+\frac{\sqrt{y(x)+1}}{(-x^2-2x+y(x))\left(\sqrt{y(x)+1}-1-x\right)} \\
&+\frac{1}{(-x^2-2x+y(x))\left(\sqrt{y(x)+1}-1-x\right)} - c_1 = 0
\end{aligned}$$

✓ Solution by Mathematica

Time used: 0.248 (sec). Leaf size: 60

```
DSolve[(x+1)*y'[x]-(y[x]+1)==(x+1)*Sqrt[y[x]+1],y[x],x,IncludeSingularSolutions -> True]
```

$$\text{Solve}\left[\frac{2\sqrt{y(x)+1}\arctan\left(\frac{x+1}{\sqrt{-y(x)-1}}\right)}{\sqrt{-y(x)-1}}+\log\left(y(x)-(x+1)^2+1\right)-\log(x+1)=c_1,y(x)\right]$$

6.4 problem Exercise 12.4, page 103

Internal problem ID [4016]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.4, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class C‘], _dAlembert]`

$$\boxed{e^{y}(1+y') - e^{x} = 0}$$

✓ Solution by Maple

Time used: 0.063 (sec). Leaf size: 16

```
dsolve(exp(y(x))*(diff(y(x),x)+1)=exp(x),y(x), singsol=all)
```

$$y(x) = x + \ln\left(\frac{c_1 e^{-2x}}{2} + \frac{1}{2}\right)$$

✓ Solution by Mathematica

Time used: 1.335 (sec). Leaf size: 22

```
DSolve[Exp[y[x]]*(y'[x]+1)==Exp[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -x + \log\left(\frac{e^{2x}}{2} + c_1\right)$$

6.5 problem Exercise 12.5, page 103

Internal problem ID [4017]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.5, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_separable]`

$$\boxed{y' \sin(y) + \sin(x)\cos(y) - \sin(x) = 0}$$

✓ Solution by Maple

Time used: 0.141 (sec). Leaf size: 14

```
dsolve(diff(y(x),x)*sin(y(x))+sin(x)*cos(y(x))=sin(x),y(x), singsol=all)
```

$$y(x) = \arccos\left(e^{-\cos(x)}c_1 + 1\right)$$

✓ Solution by Mathematica

Time used: 7.863 (sec). Leaf size: 31

```
DSolve[y'[x]*Sin[y[x]]+Sin[x]*Cos[y[x]]==Sin[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to 0$$
$$y(x) \to 2\arcsin\left(e^{\frac{1}{4}(-2\cos(x)+c_1)}\right)$$
$$y(x) \to 0$$

6.6 problem Exercise 12.6, page 103

Internal problem ID [4018]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.6, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class C‘], _dAlembert]`

$$\boxed{(-y+x)^2 y' - 4 = 0}$$

✓ Solution by Maple

Time used: 0.125 (sec). Leaf size: 27

```
dsolve((x-y(x))^2*diff(y(x),x)=4,y(x), singsol=all)
```

$$y(x) - \ln(y(x) - x + 2) + \ln(y(x) - x - 2) - c_1 = 0$$

✓ Solution by Mathematica

Time used: 0.211 (sec). Leaf size: 36

```
DSolve[(x-y[x])^2*y'[x]==4,y[x],x,IncludeSingularSolutions -> True]
```

$$\text{Solve}\left[y(x) - 4\left(\frac{1}{4}\log(y(x) - x + 2) - \frac{1}{4}\log(-y(x) + x + 2)\right) = c_1, y(x)\right]$$

6.7 problem Exercise 12.7, page 103

Internal problem ID [4019]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.7, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, 'class A'], _rational, _dAlembert]`

$$-y + y'x - \sqrt{y^2 + x^2} = 0$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 27

```
dsolve(x*diff(y(x),x)-y(x)=sqrt(x^2+y(x)^2),y(x), singsol=all)
```

$$\frac{y(x)}{x^2} + \frac{\sqrt{x^2 + y(x)^2}}{x^2} - c_1 = 0$$

✓ Solution by Mathematica

Time used: 0.336 (sec). Leaf size: 27

```
DSolve[x*y'[x]-y[x]==Sqrt[x^2+y[x]^2],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{2} e^{-c_1} \left(-1 + e^{2c_1} x^2\right)$$

6.8 problem Exercise 12.8, page 103

Internal problem ID [4020]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.8, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class C‘], _exact, _rational, [_Abel, ‘2nd typ`

$$\boxed{(3x + 2y + 1) y' + 4x + 3y + 2 = 0}$$

✓ Solution by Maple

Time used: 0.312 (sec). Leaf size: 33

```
dsolve((3*x+2*y(x)+1)*diff(y(x),x)+(4*x+3*y(x)+2)=0,y(x), singsol=all)
```

$$y(x) = -2 - \frac{\frac{3c_1(x-1)}{2} + \frac{\sqrt{(x-1)^2 c_1^2+4}}{2}}{c_1}$$

✓ Solution by Mathematica

Time used: 0.119 (sec). Leaf size: 57

```
DSolve[(3*x+2*y[x]+1)*y'[x]+(4*x+3*y[x]+2)==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{2}\left(-3x - \sqrt{(x-1)^2 + 4c_1} - 1\right)$$
$$y(x) \to \frac{1}{2}\left(-3x + \sqrt{(x-1)^2 + 4c_1} - 1\right)$$

6.9 problem Exercise 12.9, page 103

Internal problem ID [4021]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.9, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, 'class A'], _rational, _dAlembert]`

$$\boxed{(x^2 - y^2)\, y' - 2xy = 0}$$

✓ Solution by Maple

Time used: 0.032 (sec). Leaf size: 45

```
dsolve((x^2-y(x)^2)*diff(y(x),x)=2*x*y(x),y(x), singsol=all)
```

$$y(x) = -\frac{-1 + \sqrt{-4c_1^2x^2 + 1}}{2c_1}$$
$$y(x) = \frac{1 + \sqrt{-4c_1^2x^2 + 1}}{2c_1}$$

✓ Solution by Mathematica

Time used: 0.98 (sec). Leaf size: 66

```
DSolve[(x^2-y[x]^2)*y'[x]==2*x*y[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{2}\left(e^{c_1} - \sqrt{-4x^2 + e^{2c_1}}\right)$$
$$y(x) \to \frac{1}{2}\left(\sqrt{-4x^2 + e^{2c_1}} + e^{c_1}\right)$$
$$y(x) \to 0$$

6.10 problem Exercise 12.10, page 103

Internal problem ID [4022]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.10, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_1st_order, _with_linear_symmetries]]`

$$\boxed{y + (1 + y^2 e^{2x})\, y' = 0}$$

✓ Solution by Maple

Time used: 0.031 (sec). Leaf size: 18

```
dsolve(y(x)+(1+y(x)^2*exp(2*x))*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{e^{-x}}{\sqrt{\operatorname{LambertW}(c_1 e^{-2x})}}$$

✓ Solution by Mathematica

Time used: 3.361 (sec). Leaf size: 57

```
DSolve[y[x]+(1+y[x]^2*Exp[2*x])*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -\frac{e^{-x}}{\sqrt{W(e^{-2x+2c_1})}}$$

$$y(x) \to \frac{e^{-x}}{\sqrt{W(e^{-2x+2c_1})}}$$

$$y(x) \to 0$$

6.11 problem Exercise 12.11, page 103

Internal problem ID [4023]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.11, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class G‘], _rational, _Bernoulli]`

$$\boxed{x^2y + y^2 + x^3y' = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 19

```
dsolve((x^2*y(x)+y(x)^2)+x^3*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = \frac{3x^2}{3c_1x^3 - 1}$$

✓ Solution by Mathematica

Time used: 0.149 (sec). Leaf size: 26

```
DSolve[(x^2*y[x]+y[x]^2)+x^3*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{3x^2}{-1 + 3c_1x^3}$$
$$y(x) \to 0$$

6.12 problem Exercise 12.12, page 103

Internal problem ID [4024]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.12, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_exact]`

$$y^2 e^{x y^2} + 4x^3 + \left(2xy\, e^{x y^2} - 3y^2\right) y' = 0$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 21

```
dsolve((y(x)^2*exp(x*y(x)^2)+4*x^3)+(2*x*y(x)*exp(x*y(x)^2)-3*y(x)^2)*diff(y(x),x)=0,y(x), si
```

$$e^{y(x)^2 x} + x^4 - y(x)^3 + c_1 = 0$$

✓ Solution by Mathematica

Time used: 0.285 (sec). Leaf size: 24

```
DSolve[(y[x]^2*Exp[x*y[x]^2]+4*x^3)+(2*x*y[x]*Exp[x*y[x]^2]-3*y[x]^2)*y'[x]==0,y[x],x,Include
```

$$\text{Solve}\left[x^4 + e^{x y(x)^2} - y(x)^3 = c_1, y(x)\right]$$

6.13 problem Exercise 12.13, page 103

Internal problem ID [4025]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.13, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_1st_order, _with_linear_symmetries]]`

$$\boxed{y' - (x^2 + 2y - 1)^{\frac{2}{3}} + x = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 21

```
dsolve(diff(y(x),x)=(x^2+2*y(x)-1)^(2/3)-x,y(x), singsol=all)
```

$$x - \frac{3(x^2 + 2y(x) - 1)^{\frac{1}{3}}}{2} - c_1 = 0$$

✓ Solution by Mathematica

Time used: 0.224 (sec). Leaf size: 40

```
DSolve[y'[x]==(x^2+2*y[x]-1)^(2/3)-x,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{54}\left(8x^3 - 3(9 + 8c_1)x^2 + 24{c_1}^2x + 27 - 8{c_1}^3\right)$$

6.14 problem Exercise 12.14, page 103

Internal problem ID [4026]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.14, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_Bernoulli]`

$$\boxed{y'x + y - x^2(\mathrm{e}^x + 1)\, y^2 = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 18

```
dsolve(x*diff(y(x),x)+y(x)=x^2*(1+exp(x))*y(x)^2,y(x), singsol=all)
```

$$y(x) = -\frac{1}{(x + \mathrm{e}^x - c_1)\, x}$$

✓ Solution by Mathematica

Time used: 0.257 (sec). Leaf size: 55

```
DSolve[x*y'[x]+y[x]==x^2*(1+exp[x])*y[x]^2,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{-x \int_1^x (\exp(K[1]) + 1) dK[1] + c_1 x}$$

$$y(x) \to 0$$

$$y(x) \to -\frac{1}{x \int_1^x (\exp(K[1]) + 1) dK[1]}$$

6.15 problem Exercise 12.15, page 103

Internal problem ID [4027]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.15, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_separable]`

$$\boxed{2y - xy\ln(x) - 2y'x\ln(x) = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 12

```
dsolve((2*y(x)-x*y(x)*ln(x))-2*x*ln(x)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = c_1 e^{-\frac{x}{2}} \ln(x)$$

✓ Solution by Mathematica

Time used: 0.036 (sec). Leaf size: 22

```
DSolve[(2*y[x]-x*y[x]*Log[x])-2*x*Log[x]*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to c_1 e^{-x/2} \log(x)$$
$$y(x) \to 0$$

6.16 problem Exercise 12.16, page 103

Internal problem ID [4028]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.16, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_linear, ‘class A‘]]`

$$\boxed{y' + ya - k\,\mathrm{e}^{bx} = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 25

```
dsolve(diff(y(x),x)+a*y(x)=k*exp(b*x),y(x), singsol=all)
```

$$y(x) = \left(\frac{k\,\mathrm{e}^{x(a+b)}}{a+b} + c_1\right)\mathrm{e}^{-ax}$$

✓ Solution by Mathematica

Time used: 0.072 (sec). Leaf size: 33

```
DSolve[y'[x]+a*y[x]==k*Exp[b*x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{e^{-ax}\left(ke^{x(a+b)} + c_1(a+b)\right)}{a+b}$$

6.17 problem Exercise 12.17, page 103

Internal problem ID [4029]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.17, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class C‘], _Riccati]`

$$\boxed{y' - (y + x)^2 = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 16

```
dsolve(diff(y(x),x)=(x+y(x))^2,y(x), singsol=all)
```

$$y(x) = -x - \tan(c_1 - x)$$

✓ Solution by Mathematica

Time used: 0.473 (sec). Leaf size: 14

```
DSolve[y'[x]==(x+y[x])^2,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -x + \tan(x + c_1)$$

6.18 problem Exercise 12.18, page 103

Internal problem ID [4030]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.18, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_Bernoulli]`

$$\boxed{y' + 8x^3y^3 + 2xy = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 43

```
dsolve(diff(y(x),x)+8*x^3*y(x)^3+2*x*y(x)=0,y(x), singsol=all)
```

$$y(x) = \frac{1}{\sqrt{e^{2x^2}c_1 - 4x^2 - 2}}$$
$$y(x) = -\frac{1}{\sqrt{e^{2x^2}c_1 - 4x^2 - 2}}$$

✓ Solution by Mathematica

Time used: 7.049 (sec). Leaf size: 58

```
DSolve[y'[x]+8*x^3*y[x]^3+2*x*y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -\frac{1}{\sqrt{-4x^2 + c_1e^{2x^2} - 2}}$$
$$y(x) \to \frac{1}{\sqrt{-4x^2 + c_1e^{2x^2} - 2}}$$
$$y(x) \to 0$$

6.19 problem Exercise 12.19, page 103

Internal problem ID [4031]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.19, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[NONE]`

$$\left(xy\sqrt{x^2-y^2}+x\right)y'-y+x^2\sqrt{x^2-y^2}=0$$

✓ Solution by Maple

Time used: 0.031 (sec). Leaf size: 34

```
dsolve((x*y(x)*sqrt(x^2-y(x)^2)+x)*diff(y(x),x)=y(x)-x^2*sqrt(x^2-y(x)^2),y(x), singsol=all)
```

$$\frac{y(x)^2}{2}+\arctan\left(\frac{y(x)}{\sqrt{x^2-y(x)^2}}\right)+\frac{x^2}{2}-c_1=0$$

✓ Solution by Mathematica

Time used: 1.811 (sec). Leaf size: 44

```
DSolve[(x*y[x]*Sqrt[x^2-y[x]^2]+x)*y'[x]==y[x]-x^2*Sqrt[x^2-y[x]^2],y[x],x,IncludeSingularSol
```

$$\text{Solve}\left[-\arctan\left(\frac{\sqrt{x^2-y(x)^2}}{y(x)}\right)+\frac{x^2}{2}+\frac{y(x)^2}{2}=c_1,y(x)\right]$$

6.20 problem Exercise 12.20, page 103

Internal problem ID [4032]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.20, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_linear, ‘class A‘]]`

$$\boxed{y' + ya - b\sin(kx) = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 38

```
dsolve(diff(y(x),x)+a*y(x)=b*sin(k*x),y(x), singsol=all)
```

$$y(x) = \mathrm{e}^{-ax}c_1 - \frac{b(k\cos(kx) - \sin(kx)\,a)}{a^2 + k^2}$$

✓ Solution by Mathematica

Time used: 0.083 (sec). Leaf size: 40

```
DSolve[y'[x]+a*y[x]==b*Sin[k*x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{b(a\sin(kx) - k\cos(kx))}{a^2 + k^2} + c_1e^{-ax}$$

6.21 problem Exercise 12.21, page 103

Internal problem ID [4033]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.21, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_separable]`

$$\boxed{y'x - y^2 + 1 = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 11

```
dsolve(x*diff(y(x),x)-y(x)^2+1=0,y(x), singsol=all)
```

$$y(x) = -\tanh(\ln(x) + c_1)$$

✓ Solution by Mathematica

Time used: 0.48 (sec). Leaf size: 33

```
DSolve[x*y'[x]-y[x]^2+1==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -1 + \frac{2}{1 + e^{2c_1}x^2}$$
$$y(x) \to -1$$
$$y(x) \to 1$$

6.22 problem Exercise 12.22, page 103

Internal problem ID [4034]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.22, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_1st_order, '_with_symmetry_[F(x)*G(y),0]']]`

$$\boxed{\left(y^2 + a\sin(x)\right)y' - \cos(x) = 0}$$

✓ Solution by Maple

Time used: 0.031 (sec). Leaf size: 41

```
dsolve((y(x)^2+a*sin(x))*diff(y(x),x)=cos(x),y(x), singsol=all)
```

$$-\mathrm{e}^{-ay(x)}\sin(x) - \frac{\left(a^2y(x)^2 + 2ay(x) + 2\right)\mathrm{e}^{-ay(x)}}{a^3} + c_1 = 0$$

✓ Solution by Mathematica

Time used: 0.196 (sec). Leaf size: 45

```
DSolve[(y[x]^2+a*Sin[x])*y'[x]==Cos[x],y[x],x,IncludeSingularSolutions -> True]
```

$$\text{Solve}\left[\sin(x)\left(-e^{-ay(x)}\right) - \frac{e^{-ay(x)}(a^2y(x)^2 + 2ay(x) + 2)}{a^3} = c_1, y(x)\right]$$

6.23 problem Exercise 12.23, page 103

Internal problem ID [4035]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.23, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class A‘], _dAlembert]`

$$\boxed{y'x - x\,\mathrm{e}^{\frac{y}{x}} - x - y = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 20

```
dsolve(x*diff(y(x),x)=x*exp(y(x)/x)+x+y(x),y(x), singsol=all)
```

$$y(x) = \left(\ln\left(-\frac{x}{x\,\mathrm{e}^{c_1} - 1}\right) + c_1\right)x$$

✓ Solution by Mathematica

Time used: 4.547 (sec). Leaf size: 30

```
DSolve[x*y'[x]==x*Exp[y[x]/x]+x+y[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to x \log\left(-1 + \frac{1}{1 + e^{c_1}x}\right)$$
$$y(x) \to i\pi x$$

6.24 problem Exercise 12.24, page 103

Internal problem ID [4036]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.24, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_linear]`

$$\boxed{y' + y\cos(x) - \mathrm{e}^{-\sin(x)} = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 13

```
dsolve(diff(y(x),x)+y(x)*cos(x)=exp(-sin(x)),y(x), singsol=all)
```

$$y(x) = (x + c_1)\,\mathrm{e}^{-\sin(x)}$$

✓ Solution by Mathematica

Time used: 0.123 (sec). Leaf size: 16

```
DSolve[y'[x]+y[x]*Cos[x]==Exp[-Sin[x]],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to (x + c_1)e^{-\sin(x)}$$

6.25 problem Exercise 12.25, page 103

Internal problem ID [4037]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.25, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class G‘]]`

$$\boxed{y'x - y(\ln(xy) - 1) = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 14

```
dsolve(x*diff(y(x),x)-y(x)*(ln(x*y(x))-1)=0,y(x), singsol=all)
```

$$y(x) = \frac{e^{\frac{x}{c_1}}}{x}$$

✓ Solution by Mathematica

Time used: 0.196 (sec). Leaf size: 24

```
DSolve[x*y'[x]-y[x]*(Log[x*y[x]]-1)==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{e^{e^{c_1} x}}{x}$$
$$y(x) \to \frac{1}{x}$$

6.26 problem Exercise 12.26, page 103

Internal problem ID [4038]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.26, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class D‘], _rational, _Bernoulli]`

$$\boxed{x^3y' - y^2 - x^2y = 0}$$

✓ Solution by Maple

Time used: 0.015 (sec). Leaf size: 15

```
dsolve(x^3*diff(y(x),x)-y(x)^2-x^2*y(x)=0,y(x), singsol=all)
```

$$y(x) = \frac{x^2}{c_1x + 1}$$

✓ Solution by Mathematica

Time used: 0.132 (sec). Leaf size: 22

```
DSolve[x^3*y'[x]-y[x]^2-x^2*y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{x^2}{1 + c_1x}$$

$$y(x) \to 0$$

6.27 problem Exercise 12.27, page 103

Internal problem ID [4039]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.27, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_linear]`

$$\boxed{y'x + ya + b\,x^n = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 23

```
dsolve(x*diff(y(x),x)+a*y(x)+b*x^n=0,y(x), singsol=all)
```

$$y(x) = -\frac{b\,x^n}{a+n} + x^{-a}c_1$$

✓ Solution by Mathematica

Time used: 0.057 (sec). Leaf size: 25

```
DSolve[x*y'[x]+a*y[x]+b*x^n==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -\frac{bx^n}{a+n} + c_1x^{-a}$$

6.28 problem Exercise 12.28, page 103

Internal problem ID [4040]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.28, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, 'class A'], _dAlembert]`

$$\boxed{y'x - x\sin\left(\frac{y}{x}\right) - y = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 44

```
dsolve(x*diff(y(x),x)-x*sin(y(x)/x)-y(x)=0,y(x), singsol=all)
```

$$y(x) = \arctan\left(\frac{2xc_1}{c_1^2x^2+1}, -\frac{c_1^2x^2-1}{c_1^2x^2+1}\right)x$$

✓ Solution by Mathematica

Time used: 2.767 (sec). Leaf size: 33

```
DSolve[x*y'[x]-x*Sin[y[x]/x]-y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to 2x\arctan\left(e^{c_1}x\right)$$
$$y(x) \to 0$$
$$y(x) \to \pi\sqrt{x^2}$$

6.29 problem Exercise 12.29, page 103

Internal problem ID [4041]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.29, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class A‘], _rational, [_Abel, ‘2nd type‘, ‘cla`

$$\boxed{y^2 - 3xy - 2x^2 + (xy - x^2)\, y' = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 59

```
dsolve((x*y(x)-x^2)*diff(y(x),x)+y(x)^2-3*x*y(x)-2*x^2=0,y(x), singsol=all)
```

$$y(x) = \frac{c_1 x^2 - \sqrt{2c_1^2 x^4 + 1}}{c_1 x}$$
$$y(x) = \frac{c_1 x^2 + \sqrt{2c_1^2 x^4 + 1}}{c_1 x}$$

✓ Solution by Mathematica

Time used: 0.697 (sec). Leaf size: 99

```
DSolve[(x*y[x]-x^2)*y'[x]+y[x]^2-3*x*y[x]-2*x^2==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to x - \frac{\sqrt{2x^4 + e^{2c_1}}}{x}$$
$$y(x) \to x + \frac{\sqrt{2x^4 + e^{2c_1}}}{x}$$
$$y(x) \to x - \frac{\sqrt{2}\sqrt{x^4}}{x}$$
$$y(x) \to \frac{\sqrt{2}\sqrt{x^4}}{x} + x$$

6.30 problem Exercise 12.30, page 103

Internal problem ID [4042]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.30, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_exact, _rational, [_Abel, '2nd type', 'class B']]`

$$\boxed{(6xy + x^2 + 3)\, y' + 3y^2 + 2xy + 2x = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 71

```
dsolve((6*x*y(x)+x^2+3)*diff(y(x),x)+3*y(x)^2+2*x*y(x)+2*x=0,y(x), singsol=all)
```

$$y(x) = \frac{-x^2 - 3 + \sqrt{x^4 - 12x^3 - 12c_1x + 6x^2 + 9}}{6x}$$

$$y(x) = -\frac{x^2 + \sqrt{x^4 - 12x^3 - 12c_1x + 6x^2 + 9} + 3}{6x}$$

✓ Solution by Mathematica

Time used: 0.5 (sec). Leaf size: 79

```
DSolve[(6*x*y[x]+x^2+3)*y'[x]+3*y[x]^2+2*x*y[x]+2*x==0,y[x],x,IncludeSingularSolutions -> Tru
```

$$y(x) \to -\frac{x^2 + \sqrt{9 + x(x((x-12)x+6) + 36c_1)} + 3}{6x}$$

$$y(x) \to \frac{-x^2 + \sqrt{9 + x(x((x-12)x+6) + 36c_1)} - 3}{6x}$$

6.31 problem Exercise 12.31, page 103

Internal problem ID [4043]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.31, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class A‘], _rational, _Riccati]`

$$\boxed{x^2y' + y^2 + xy + x^2 = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 18

```
dsolve(x^2*diff(y(x),x)+y(x)^2+x*y(x)+x^2=0,y(x), singsol=all)
```

$$y(x) = -\frac{x(\ln(x) + c_1 - 1)}{\ln(x) + c_1}$$

✓ Solution by Mathematica

Time used: 0.146 (sec). Leaf size: 25

```
DSolve[x^2*y'[x]+y[x]^2+x*y[x]+x^2==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to x\left(-1 + \frac{1}{\log(x) - c_1}\right)$$
$$y(x) \to -x$$

6.32 problem Exercise 12.32, page 103

Internal problem ID [4044]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.32, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_linear]`

$$\boxed{(x^2 - 1)\, y' + 2xy - \cos(x) = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 19

```
dsolve((x^2-1)*diff(y(x),x)+2*x*y(x)-cos(x)=0,y(x), singsol=all)
```

$$y(x) = \frac{\sin(x) + c_1}{(x-1)(x+1)}$$

✓ Solution by Mathematica

Time used: 0.038 (sec). Leaf size: 18

```
DSolve[(x^2-1)*y'[x]+2*x*y[x]-Cos[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{\sin(x) + c_1}{x^2 - 1}$$

6.33 problem Exercise 12.33, page 103

Internal problem ID [4045]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.33, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_exact, _rational, [_Abel, '2nd type', 'class B']]`

$$\boxed{(x^2y-1)\,y'+xy^2-1=0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 50

```
dsolve((x^2*y(x)-1)*diff(y(x),x)+x*y(x)^2-1=0,y(x), singsol=all)
```

$$y(x)=\frac{1+\sqrt{-2c_1x^2+2x^3+1}}{x^2}$$
$$y(x)=-\frac{-1+\sqrt{-2c_1x^2+2x^3+1}}{x^2}$$

✓ Solution by Mathematica

Time used: 0.518 (sec). Leaf size: 55

```
DSolve[(x^2*y[x]-1)*y'[x]+x*y[x]^2-1==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x)\to\frac{1-\sqrt{1+x^2(2x+c_1)}}{x^2}$$
$$y(x)\to\frac{1+\sqrt{1+x^2(2x+c_1)}}{x^2}$$

6.34 problem Exercise 12.34, page 103

Internal problem ID [4046]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.34, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_separable]`

$$\boxed{(x^2-1)\,y'+xy-3xy^2=0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 20

```
dsolve((x^2-1)*diff(y(x),x)+x*y(x)-3*x*y(x)^2=0,y(x), singsol=all)
```

$$y(x)=\frac{1}{3+\sqrt{x-1}\,\sqrt{x+1}\,c_1}$$

✓ Solution by Mathematica

Time used: 2.27 (sec). Leaf size: 35

```
DSolve[(x^2-1)*y'[x]+x*y[x]-3*x*y[x]^2==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x)\to\frac{1}{3+e^{c_1}\sqrt{x^2-1}}$$
$$y(x)\to 0$$
$$y(x)\to\frac{1}{3}$$

6.35 problem Exercise 12.35, page 103

Internal problem ID [4047]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.35, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_separable]`

$$\boxed{(x^2-1)\,y'-2xy\ln(y)=0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 13

```
dsolve((x^2-1)*diff(y(x),x)-2*x*y(x)*ln(y(x))=0,y(x), singsol=all)
```

$$y(x)=\mathrm{e}^{c_1(x+1)(x-1)}$$

✓ Solution by Mathematica

Time used: 0.225 (sec). Leaf size: 22

```
DSolve[(x^2-1)*y'[x]-2*x*y[x]*Log[y[x]]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x)\to e^{e^{c_1}(x^2-1)}$$
$$y(x)\to 1$$

6.36 problem Exercise 12.36, page 103

Internal problem ID [4048]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.36, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_exact, _rational]`

$$\boxed{(1 + x^2 + y^2)\, y' + 2xy + x^2 + 3 = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 570

```
dsolve((x^2+y(x)^2+1)*diff(y(x),x)+2*x*y(x)+x^2+3=0,y(x), singsol=all)
```

$$y(x) = \frac{\left(-4x^3-12c_1-36x+4\sqrt{5x^6+6c_1x^3+30x^4+9c_1^2+54c_1x+93x^2+4}\right)^{\frac{1}{3}}}{2} - \frac{2(x^2+1)}{\left(-4x^3-12c_1-36x+4\sqrt{5x^6+6c_1x^3+30x^4+9c_1^2+54c_1x+93x^2+4}\right)^{\frac{1}{3}}}$$

$$y(x) = -\frac{\left(-4x^3-12c_1-36x+4\sqrt{5x^6+6c_1x^3+30x^4+9c_1^2+54c_1x+93x^2+4}\right)^{\frac{1}{3}}}{4} + \frac{x^2+1}{\left(-4x^3-12c_1-36x+4\sqrt{5x^6+6c_1x^3+30x^4+9c_1^2+54c_1x+93x^2+4}\right)^{\frac{1}{3}}} - \frac{i\sqrt{3}\left(\frac{\left(-4x^3-12c_1-36x+4\sqrt{5x^6+6c_1x^3+30x^4+9c_1^2+54c_1x+93x^2+4}\right)^{\frac{1}{3}}}{2} + \frac{2x^2+2}{\left(-4x^3-12c_1-36x+4\sqrt{5x^6+6c_1x^3+30x^4+9c_1^2+54c_1x+93}\right.}\right.}{2}$$

$$y(x) = -\frac{\left(-4x^3-12c_1-36x+4\sqrt{5x^6+6c_1x^3+30x^4+9c_1^2+54c_1x+93x^2+4}\right)^{\frac{1}{3}}}{4} + \frac{x^2+1}{\left(-4x^3-12c_1-36x+4\sqrt{5x^6+6c_1x^3+30x^4+9c_1^2+54c_1x+93x^2+4}\right)^{\frac{1}{3}}} + \frac{i\sqrt{3}\left(\frac{\left(-4x^3-12c_1-36x+4\sqrt{5x^6+6c_1x^3+30x^4+9c_1^2+54c_1x+93x^2+4}\right)^{\frac{1}{3}}}{2} + \frac{2x^2+2}{\left(-4x^3-12c_1-36x+4\sqrt{5x^6+6c_1x^3+30x^4+9c_1^2+54c_1x+93}\right.}\right.}{2}$$

✓ Solution by Mathematica

Time used: 5.478 (sec). Leaf size: 411

```
DSolve[(x^2+y[x]^2+1)*y'[x]+2*x*y[x]+x^2+3==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{\sqrt[3]{-27x^3+\sqrt{4\left(9x^2+9\right)^3+729\left(x^3+9x-3c_1\right)^2}-243x+81c_1}}{3\sqrt[3]{2}} - \frac{3\sqrt[3]{2}(x^2+1)}{\sqrt[3]{-27x^3+\sqrt{4\left(9x^2+9\right)^3+729\left(x^3+9x-3c_1\right)^2}-243x+81c_1}}$$

$$y(x) \to \frac{3\left(1+i\sqrt{3}\right)\left(x^2+1\right)}{2^{2/3}\sqrt[3]{-27x^3+\sqrt{4\left(9x^2+9\right)^3+729\left(x^3+9x-3c_1\right)^2}-243x+81c_1}} + \frac{\left(-1+i\sqrt{3}\right)\sqrt[3]{-27x^3+\sqrt{4\left(9x^2+9\right)^3+729\left(x^3+9x-3c_1\right)^2}-243x+81c_1}}{6\sqrt[3]{2}}$$

$$y(x) \to \frac{3\left(1-i\sqrt{3}\right)\left(x^2+1\right)}{2^{2/3}\sqrt[3]{-27x^3+\sqrt{4\left(9x^2+9\right)^3+729\left(x^3+9x-3c_1\right)^2}-243x+81c_1}} - \frac{\left(1+i\sqrt{3}\right)\sqrt[3]{-27x^3+\sqrt{4\left(9x^2+9\right)^3+729\left(x^3+9x-3c_1\right)^2}-243x+81c_1}}{6\sqrt[3]{2}}$$

6.37 problem Exercise 12.37, page 103

Internal problem ID [4049]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.37, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_linear]`

$$\cos(x) y' + y + (\sin(x) + 1)\cos(x) = 0$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 29

```
dsolve(diff(y(x),x)*cos(x)+y(x)+(1+sin(x))*cos(x)=0,y(x), singsol=all)
```

$$y(x) = \frac{-2\ln(\sec(x) + \tan(x)) + 2\ln(\cos(x)) + \sin(x) + c_1}{\sec(x) + \tan(x)}$$

✓ Solution by Mathematica

Time used: 0.687 (sec). Leaf size: 40

```
DSolve[y'[x]*Cos[x]+y[x]+(1+Sin[x])*Cos[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^{-2\operatorname{arctanh}\left(\tan\left(\frac{x}{2}\right)\right)}\left(\sin(x) + 4\log\left(\cos\left(\frac{x}{2}\right) - \sin\left(\frac{x}{2}\right)\right) + c_1\right)$$

6.38 problem Exercise 12.38, page 103

Internal problem ID [4050]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.38, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class G‘], _exact, _rational, [_Abel, ‘2nd typ`

$$\boxed{(2xy + 4x^3)\, y' + y^2 + 12x^2y = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 50

```
dsolve((2*x*y(x)+4*x^3)*diff(y(x),x)+y(x)^2+12*x^2*y(x)=0,y(x), singsol=all)
```

$$y(x) = \frac{-2x^3 + \sqrt{4x^6 + c_1x}}{x}$$
$$y(x) = -\frac{2x^3 + \sqrt{4x^6 + c_1x}}{x}$$

✓ Solution by Mathematica

Time used: 0.449 (sec). Leaf size: 58

```
DSolve[(2*x*y[x]+4*x^3)*y'[x]+y[x]^2+12*x^2*y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -\frac{2x^3 + \sqrt{x(4x^5 + c_1)}}{x}$$
$$y(x) \to \frac{-2x^3 + \sqrt{x(4x^5 + c_1)}}{x}$$

6.39 problem Exercise 12.39, page 103

Internal problem ID [4051]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.39, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_rational, [_1st_order, '_with_symmetry_[F(x)*G(y),0]'], [_Abe`

$$\boxed{(x^2 - y)\, y' + x = 0}$$

✓ Solution by Maple

Time used: 0.015 (sec). Leaf size: 23

```
dsolve((x^2-y(x))*diff(y(x),x)+x=0,y(x), singsol=all)
```

$$y(x) = x^2 + \frac{\operatorname{LambertW}\left(4c_1 \mathrm{e}^{-2x^2-1}\right)}{2} + \frac{1}{2}$$

✓ Solution by Mathematica

Time used: 5.491 (sec). Leaf size: 40

```
DSolve[(x^2-y[x])*y'[x]+x==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to x^2 + \frac{1}{2}\left(1 + W\left(-e^{-2x^2-1+c_1}\right)\right)$$
$$y(x) \to x^2 + \frac{1}{2}$$

6.40 problem Exercise 12.40, page 103

Internal problem ID [4052]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.40, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class G‘], _rational, [_Abel, ‘2nd type‘, ‘cla`

$$\boxed{(x^2 - y)\, y' - 4xy = 0}$$

✓ Solution by Maple

Time used: 0.062 (sec). Leaf size: 53

```
dsolve((x^2-y(x))*diff(y(x),x)-4*x*y(x)=0,y(x), singsol=all)
```

$$y(x) = \frac{c_1\left(c_1 - \sqrt{c_1^2 - 4x^2}\right)}{2} - x^2$$
$$y(x) = \frac{c_1\left(c_1 + \sqrt{c_1^2 - 4x^2}\right)}{2} - x^2$$

✓ Solution by Mathematica

Time used: 2.466 (sec). Leaf size: 206

```
DSolve[(x^2-y[x])*y'[x]-4*x*y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to x^2 \left(1 + \frac{2-2i}{\frac{i\sqrt{2}}{\sqrt{e^{\frac{2c_1}{9}}x^2 - i}} - (1-i)}\right)$$

$$y(x) \to x^2 \left(1 + \frac{2-2i}{(-1+i) - \frac{i\sqrt{2}}{\sqrt{e^{\frac{2c_1}{9}}x^2 - i}}}\right)$$

$$y(x) \to x^2 \left(1 + \frac{2-2i}{(-1+i) - \frac{\sqrt{2}}{\sqrt{e^{\frac{2c_1}{9}}x^2 + i}}}\right)$$

$$y(x) \to x^2 \left(1 + \frac{2-2i}{\frac{\sqrt{2}}{\sqrt{e^{\frac{2c_1}{9}}x^2 + i}} - (1-i)}\right)$$

$$y(x) \to 0$$

$$y(x) \to -x^2$$

6.41 problem Exercise 12.41, page 103

Internal problem ID [4053]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.41, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class A‘], _rational, _Bernoulli]`

$$\boxed{xyy' + x^2 + y^2 = 0}$$

✓ Solution by Maple

Time used: 0.015 (sec). Leaf size: 39

```
dsolve(x*y(x)*diff(y(x),x)+x^2+y(x)^2=0,y(x), singsol=all)
```

$$y(x) = -\frac{\sqrt{-2x^4 + 4c_1}}{2x}$$
$$y(x) = \frac{\sqrt{-2x^4 + 4c_1}}{2x}$$

✓ Solution by Mathematica

Time used: 0.222 (sec). Leaf size: 46

```
DSolve[x*y[x]*y'[x]+x^2+y[x]^2==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -\frac{\sqrt{-\frac{x^4}{2} + c_1}}{x}$$
$$y(x) \to \frac{\sqrt{-\frac{x^4}{2} + c_1}}{x}$$

6.42 problem Exercise 12.42, page 103

Internal problem ID [4054]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.42, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class A‘], _rational, _Bernoulli]`

$$\boxed{2xyy' + 3x^2 - y^2 = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 31

```
dsolve(2*x*y(x)*diff(y(x),x)+3*x^2-y(x)^2=0,y(x), singsol=all)
```

$$y(x) = \sqrt{c_1 x - 3x^2}$$
$$y(x) = -\sqrt{c_1 x - 3x^2}$$

✓ Solution by Mathematica

Time used: 0.313 (sec). Leaf size: 35

```
DSolve[2*x*y[x]*y'[x]+3*x^2-y[x]^2==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -\sqrt{x(-3x + c_1)}$$
$$y(x) \to \sqrt{x(-3x + c_1)}$$

6.43 problem Exercise 12.43, page 103

Internal problem ID [4055]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.43, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class A‘], _rational, _dAlembert]`

$$\boxed{(2y^3x - x^4)\, y' + 2yx^3 - y^4 = 0}$$

✓ Solution by Maple

Time used: 0.015 (sec). Leaf size: 447

```
dsolve((2*x*y(x)^3-x^4)*diff(y(x),x)+2*x^3*y(x)-y(x)^4=0,y(x), singsol=all)
```

$$y(x) = \frac{12^{\frac{1}{3}}\left(x\left(-9c_1x^2+\sqrt{3}\,\sqrt{\frac{x(27c_1^3x^3-4)}{c_1}}\right)c_1^2\right)^{\frac{1}{3}}}{6c_1} + \frac{x12^{\frac{2}{3}}}{6\left(x\left(-9c_1x^2+\sqrt{3}\,\sqrt{\frac{x(27c_1^3x^3-4)}{c_1}}\right)c_1^2\right)^{\frac{1}{3}}}$$

$$y(x) = -\frac{12^{\frac{1}{3}}\left(x\left(-9c_1x^2+\sqrt{3}\,\sqrt{\frac{x(27c_1^3x^3-4)}{c_1}}\right)c_1^2\right)^{\frac{1}{3}}}{12c_1} - \frac{x12^{\frac{2}{3}}}{12\left(x\left(-9c_1x^2+\sqrt{3}\,\sqrt{\frac{x(27c_1^3x^3-4)}{c_1}}\right)c_1^2\right)^{\frac{1}{3}}} - \frac{i\sqrt{3}\left(\frac{12^{\frac{1}{3}}\left(x\left(-9c_1x^2+\sqrt{3}\,\sqrt{\frac{x(27c_1^3x^3-4)}{c_1}}\right)c_1^2\right)^{\frac{1}{3}}}{6c_1} - \frac{x12^{\frac{2}{3}}}{6\left(x\left(-9c_1x^2+\sqrt{3}\,\sqrt{\frac{x(27c_1^3x^3-4)}{c_1}}\right)c_1^2\right)^{\frac{1}{3}}}\right)}{2}$$

$$y(x) = -\frac{12^{\frac{1}{3}}\left(x\left(-9c_1x^2+\sqrt{3}\,\sqrt{\frac{x(27c_1^3x^3-4)}{c_1}}\right)c_1^2\right)^{\frac{1}{3}}}{12c_1} - \frac{x12^{\frac{2}{3}}}{12\left(x\left(-9c_1x^2+\sqrt{3}\,\sqrt{\frac{x(27c_1^3x^3-4)}{c_1}}\right)c_1^2\right)^{\frac{1}{3}}} + \frac{i\sqrt{3}\left(\frac{12^{\frac{1}{3}}\left(x\left(-9c_1x^2+\sqrt{3}\,\sqrt{\frac{x(27c_1^3x^3-4)}{c_1}}\right)c_1^2\right)^{\frac{1}{3}}}{6c_1} - \frac{x12^{\frac{2}{3}}}{6\left(x\left(-9c_1x^2+\sqrt{3}\,\sqrt{\frac{x(27c_1^3x^3-4)}{c_1}}\right)c_1^2\right)^{\frac{1}{3}}}\right)}{2}$$

✓ Solution by Mathematica

Time used: 60.226 (sec). Leaf size: 294

```
DSolve[(2*x*y[x]^3-x^4)*y'[x]+2*x^3*y[x]-y[x]^4==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{\sqrt[3]{2}\left(-9x^3+\sqrt{81x^6-12e^{3c_1}x^3}\right)^{2/3}+2\sqrt[3]{3}e^{c_1}x}{6^{2/3}\sqrt[3]{-9x^3+\sqrt{81x^6-12e^{3c_1}x^3}}}$$

$$y(x) \to \frac{(-1)^{2/3}\sqrt[3]{2}\left(-9x^3+\sqrt{81x^6-12e^{3c_1}x^3}\right)^{2/3}-2\sqrt[3]{-3}e^{c_1}x}{6^{2/3}\sqrt[3]{-9x^3+\sqrt{81x^6-12e^{3c_1}x^3}}}$$

$$y(x) \to \frac{-\sqrt[3]{-2}\sqrt[6]{3}\left(-9x^3+\sqrt{81x^6-12e^{3c_1}x^3}\right)^{2/3}-\left(\left(\sqrt{3}-3i\right)e^{c_1}x\right)}{2^{2/3}3^{5/6}\sqrt[3]{-9x^3+\sqrt{81x^6-12e^{3c_1}x^3}}}$$

6.44 problem Exercise 12.44, page 103

Internal problem ID [4056]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.44, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class G‘], _rational]`

$$(xy-1)^2\,xy' + y(x^2y^2+1) = 0$$

✓ Solution by Maple

Time used: 0.094 (sec). Leaf size: 34

```
dsolve((x*y(x)-1)^2*x*diff(y(x),x)+(x^2*y(x)^2+1)*y(x)=0,y(x), singsol=all)
```

$$y(x) = \frac{e^{\mathrm{RootOf}\left(-2\,e^{-\_Z}\ln(x)-e^{2\_Z}+2\,e^{-\_Z}c_1+2\_Z\,e^{-\_Z}+1\right)}}{x}$$

✓ Solution by Mathematica

Time used: 0.112 (sec). Leaf size: 25

```
DSolve[(x*y[x]-1)^2*x*y'[x]+(x^2*y[x]^2+1)*y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$\mathrm{Solve}\left[xy(x) - \frac{1}{xy(x)} - 2\log(y(x)) = c_1, y(x)\right]$$

6.45 problem Exercise 12.45, page 103

Internal problem ID [4057]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.45, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class A‘], _exact, _rational, _dAlembert]`

$$\boxed{(y^2+x^2)\,y'+2x(y+2x)=0}$$

✓ Solution by Maple

Time used: 0.047 (sec). Leaf size: 417

```
dsolve((x^2+y(x)^2)*diff(y(x),x)+2*x*(2*x+y(x))=0,y(x), singsol=all)
```

$$y(x)=\frac{\frac{\left(4-16x^3c_1^{\frac{3}{2}}+4\sqrt{20x^6c_1^3-8x^3c_1^{\frac{3}{2}}+1}\right)^{\frac{1}{3}}}{2}-\frac{2x^2c_1}{\left(4-16x^3c_1^{\frac{3}{2}}+4\sqrt{20x^6c_1^3-8x^3c_1^{\frac{3}{2}}+1}\right)^{\frac{1}{3}}}}{\sqrt{c_1}}$$

$$y(x)=\frac{-\frac{\left(4-16x^3c_1^{\frac{3}{2}}+4\sqrt{20x^6c_1^3-8x^3c_1^{\frac{3}{2}}+1}\right)^{\frac{1}{3}}}{4}+\frac{x^2c_1}{\left(4-16x^3c_1^{\frac{3}{2}}+4\sqrt{20x^6c_1^3-8x^3c_1^{\frac{3}{2}}+1}\right)^{\frac{1}{3}}}-\frac{i\sqrt{3}\left(\frac{\left(4-16x^3c_1^{\frac{3}{2}}+4\sqrt{20x^6c_1^3-8x^3c_1^{\frac{3}{2}}+1}\right)^{\frac{1}{3}}}{2}+\frac{\cdots}{\left(4-16x\cdots\right.}\right.}{2}\cdots}{\sqrt{c_1}}$$

$$y(x)=\frac{-\frac{\left(4-16x^3c_1^{\frac{3}{2}}+4\sqrt{20x^6c_1^3-8x^3c_1^{\frac{3}{2}}+1}\right)^{\frac{1}{3}}}{4}+\frac{x^2c_1}{\left(4-16x^3c_1^{\frac{3}{2}}+4\sqrt{20x^6c_1^3-8x^3c_1^{\frac{3}{2}}+1}\right)^{\frac{1}{3}}}+\frac{i\sqrt{3}\left(\frac{\left(4-16x^3c_1^{\frac{3}{2}}+4\sqrt{20x^6c_1^3-8x^3c_1^{\frac{3}{2}}+1}\right)^{\frac{1}{3}}}{2}+\frac{\cdots}{\left(4-16x\cdots\right.}\right.}{2}\cdots}{\sqrt{c_1}}$$

✓ Solution by Mathematica

Time used: 19.158 (sec). Leaf size: 554

```
DSolve[(x^2+y[x]^2)*y'[x]+2*x*(2*x+y[x])==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{\sqrt[3]{-4x^3+\sqrt{20x^6-8e^{3c_1}x^3+e^{6c_1}}+e^{3c_1}}}{\sqrt[3]{2}} - \frac{\sqrt[3]{2}x^2}{\sqrt[3]{-4x^3+\sqrt{20x^6-8e^{3c_1}x^3+e^{6c_1}}+e^{3c_1}}}$$

$$y(x) \to \frac{2\sqrt[3]{-2}x^2+(-2)^{2/3}\left(-4x^3+\sqrt{20x^6-8e^{3c_1}x^3+e^{6c_1}}+e^{3c_1}\right)^{2/3}}{2\sqrt[3]{-4x^3+\sqrt{20x^6-8e^{3c_1}x^3+e^{6c_1}}+e^{3c_1}}}$$

$$y(x) \to -\frac{2(-1)^{2/3}x^2+\sqrt[3]{-2}\left(-4x^3+\sqrt{20x^6-8e^{3c_1}x^3+e^{6c_1}}+e^{3c_1}\right)^{2/3}}{2^{2/3}\sqrt[3]{-4x^3+\sqrt{20x^6-8e^{3c_1}x^3+e^{6c_1}}+e^{3c_1}}}$$

$$y(x) \to \sqrt[3]{\sqrt{5}\sqrt{x^6}-2x^3} - \frac{x^2}{\sqrt[3]{\sqrt{5}\sqrt{x^6}-2x^3}}$$

$$y(x) \to \frac{\left(1-i\sqrt{3}\right)x^2+\left(-1-i\sqrt{3}\right)\left(\sqrt{5}\sqrt{x^6}-2x^3\right)^{2/3}}{2\sqrt[3]{\sqrt{5}\sqrt{x^6}-2x^3}}$$

$$y(x) \to \frac{\left(1+i\sqrt{3}\right)x^2+i\left(\sqrt{3}+i\right)\left(\sqrt{5}\sqrt{x^6}-2x^3\right)^{2/3}}{2\sqrt[3]{\sqrt{5}\sqrt{x^6}-2x^3}}$$

6.46 problem Exercise 12.46, page 103

Internal problem ID [4058]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.46, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, ‘class G‘], _exact, _rational, _Bernoulli]`

$$3xy^2y' + y^3 - 2x = 0$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 99

```
dsolve(3*x*y(x)^2*diff(y(x),x)+y(x)^3-2*x=0,y(x), singsol=all)
```

$$y(x) = \frac{((x^2+c_1)\,x^2)^{\frac{1}{3}}}{x}$$
$$y(x) = -\frac{((x^2+c_1)\,x^2)^{\frac{1}{3}}}{2x} - \frac{i\sqrt{3}\,((x^2+c_1)\,x^2)^{\frac{1}{3}}}{2x}$$
$$y(x) = -\frac{((x^2+c_1)\,x^2)^{\frac{1}{3}}}{2x} + \frac{i\sqrt{3}\,((x^2+c_1)\,x^2)^{\frac{1}{3}}}{2x}$$

✓ Solution by Mathematica

Time used: 0.235 (sec). Leaf size: 72

```
DSolve[3*x*y[x]^2*y'[x]+y[x]^3-2*x==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{\sqrt[3]{x^2+c_1}}{\sqrt[3]{x}}$$
$$y(x) \to -\frac{\sqrt[3]{-1}\sqrt[3]{x^2+c_1}}{\sqrt[3]{x}}$$
$$y(x) \to \frac{(-1)^{2/3}\sqrt[3]{x^2+c_1}}{\sqrt[3]{x}}$$

6.47 problem Exercise 12.47, page 103

Internal problem ID [4059]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.47, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[[_homogeneous, 'class A'], _rational, _dAlembert]`

$$\boxed{2y^3y' + xy^2 - x^3 = 0}$$

✓ Solution by Maple

Time used: 0.453 (sec). Leaf size: 711

```
dsolve(2*y(x)^3*diff(y(x),x)+x*y(x)^2-x^3=0,y(x), singsol=all)
```

$$y(x) = -\frac{\sqrt{2\left(2+x^6c_1^3+2\sqrt{x^6c_1^3+1}\right)^{\frac{1}{3}}+\frac{2x^4c_1^2}{\left(2+x^6c_1^3+2\sqrt{x^6c_1^3+1}\right)^{\frac{1}{3}}}-2c_1x^2}}{2\sqrt{c_1}}$$

$$y(x) = \frac{\sqrt{2\left(2+x^6c_1^3+2\sqrt{x^6c_1^3+1}\right)^{\frac{1}{3}}+\frac{2x^4c_1^2}{\left(2+x^6c_1^3+2\sqrt{x^6c_1^3+1}\right)^{\frac{1}{3}}}-2c_1x^2}}{2\sqrt{c_1}}$$

$$y(x) = -\frac{\sqrt{-\left(2+x^6c_1^3+2\sqrt{x^6c_1^3+1}\right)^{\frac{1}{3}}-\frac{x^4c_1^2}{\left(2+x^6c_1^3+2\sqrt{x^6c_1^3+1}\right)^{\frac{1}{3}}}-2c_1x^2-2i\sqrt{3}\left(\frac{\left(2+x^6c_1^3+2\sqrt{x^6c_1^3+1}\right)^{\frac{1}{3}}}{2}-\frac{\cdots}{2\left(2+x^6\cdots\right.}\cdots\right.}}{2\sqrt{c_1}}$$

$$y(x) = \frac{\sqrt{-\left(2+x^6c_1^3+2\sqrt{x^6c_1^3+1}\right)^{\frac{1}{3}}-\frac{x^4c_1^2}{\left(2+x^6c_1^3+2\sqrt{x^6c_1^3+1}\right)^{\frac{1}{3}}}-2c_1x^2-2i\sqrt{3}\left(\frac{\left(2+x^6c_1^3+2\sqrt{x^6c_1^3+1}\right)^{\frac{1}{3}}}{2}-\frac{\cdots}{2\left(2+x^6c_1^3+\cdots\right.}\cdots\right.}}{2\sqrt{c_1}}$$

$$y(x) = -\frac{\sqrt{-\left(2+x^6c_1^3+2\sqrt{x^6c_1^3+1}\right)^{\frac{1}{3}}-\frac{x^4c_1^2}{\left(2+x^6c_1^3+2\sqrt{x^6c_1^3+1}\right)^{\frac{1}{3}}}-2c_1x^2+2i\sqrt{3}\left(\frac{\left(2+x^6c_1^3+2\sqrt{x^6c_1^3+1}\right)^{\frac{1}{3}}}{2}-\frac{\cdots}{2\left(2+x^6\cdots\right.}\cdots\right.}}{2\sqrt{c_1}}$$

$$y(x) = \frac{\sqrt{-\left(2+x^6c_1^3+2\sqrt{x^6c_1^3+1}\right)^{\frac{1}{3}}-\frac{x^4c_1^2}{\left(2+x^6c_1^3+2\sqrt{x^6c_1^3+1}\right)^{\frac{1}{3}}}-2c_1x^2+2i\sqrt{3}\left(\frac{\left(2+x^6c_1^3+2\sqrt{x^6c_1^3+1}\right)^{\frac{1}{3}}}{2}-\frac{\cdots}{2\left(2+x^6c_1^3+\cdots\right.}\cdots\right.}}{2\sqrt{c_1}}$$

✓ Solution by Mathematica

Time used: 60.132 (sec). Leaf size: 714

```
DSolve[2*y[x]^3*y'[x]+x*y[x]^2-x^3==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -\frac{\sqrt{\sqrt[3]{x^6+2\sqrt{e^{24c_1}-e^{12c_1}x^6}-2e^{12c_1}}-x^2+\frac{x^4}{\sqrt[3]{x^6+2\sqrt{e^{24c_1}-e^{12c_1}x^6}-2e^{12c_1}}}}}{\sqrt{2}}$$

$$y(x) \to \frac{\sqrt{\sqrt[3]{x^6+2\sqrt{e^{24c_1}-e^{12c_1}x^6}-2e^{12c_1}}-x^2+\frac{x^4}{\sqrt[3]{x^6+2\sqrt{e^{24c_1}-e^{12c_1}x^6}-2e^{12c_1}}}}}{\sqrt{2}}$$

$$y(x) \to -\frac{1}{2}\sqrt{\left(-1-i\sqrt{3}\right)\sqrt[3]{x^6+2\sqrt{e^{24c_1}-e^{12c_1}x^6}-2e^{12c_1}}-2x^2+\frac{i\left(\sqrt{3}+i\right)x^4}{\sqrt[3]{x^6+2\sqrt{e^{24c_1}-e^{12c_1}x^6}-2e^{12c_1}}}}$$

$$y(x) \to \frac{1}{2}\sqrt{\left(-1-i\sqrt{3}\right)\sqrt[3]{x^6+2\sqrt{e^{24c_1}-e^{12c_1}x^6}-2e^{12c_1}}-2x^2+\frac{i\left(\sqrt{3}+i\right)x^4}{\sqrt[3]{x^6+2\sqrt{e^{24c_1}-e^{12c_1}x^6}-2e^{12c_1}}}}$$

$$y(x) \to -\frac{1}{2}\sqrt{i\left(\sqrt{3}+i\right)\sqrt[3]{x^6+2\sqrt{e^{24c_1}-e^{12c_1}x^6}-2e^{12c_1}}-2x^2+\frac{\left(-1-i\sqrt{3}\right)x^4}{\sqrt[3]{x^6+2\sqrt{e^{24c_1}-e^{12c_1}x^6}-2e^{12c_1}}}}$$

$$y(x) \to \frac{1}{2}\sqrt{i\left(\sqrt{3}+i\right)\sqrt[3]{x^6+2\sqrt{e^{24c_1}-e^{12c_1}x^6}-2e^{12c_1}}-2x^2+\frac{\left(-1-i\sqrt{3}\right)x^4}{\sqrt[3]{x^6+2\sqrt{e^{24c_1}-e^{12c_1}x^6}-2e^{12c_1}}}}$$

6.48 problem Exercise 12.48, page 103

Internal problem ID [4060]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.48, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_rational]`

$$\boxed{(2y^3x + xy + x^2)\, y' - xy + y^2 = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 29

```
dsolve((2*x*y(x)^3+x*y(x)+x^2)*diff(y(x),x)-x*y(x)+y(x)^2=0,y(x), singsol=all)
```

$$y(x) = \mathrm{e}^{\mathrm{RootOf}\left(-\mathrm{e}^{3\_Z}-\mathrm{e}^{\_Z}\ln(x)+\mathrm{e}^{\_Z}c_1-\_Z\mathrm{e}^{\_Z}+x\right)}$$

✓ Solution by Mathematica

Time used: 0.225 (sec). Leaf size: 23

```
DSolve[(2*x*y[x]^3+x*y[x]+x^2)*y'[x]-x*y[x]+y[x]^2==0,y[x],x,IncludeSingularSolutions -> True
```

$$\text{Solve}\left[y(x)^2 - \frac{x}{y(x)} + \log(y(x)) + \log(x) = c_1, y(x)\right]$$

6.49 problem Exercise 12.49, page 103

Internal problem ID [4061]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.49, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_separable]`

$$\boxed{(2y^3 + y)\, y' - 2x^3 - x = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 113

```
dsolve((2*y(x)^3+y(x))*diff(y(x),x)-2*x^3-x=0,y(x), singsol=all)
```

$$y(x) = -\frac{\sqrt{-2 - 2\sqrt{4x^4 + 4x^2 + 8c_1 + 1}}}{2}$$

$$y(x) = \frac{\sqrt{-2 - 2\sqrt{4x^4 + 4x^2 + 8c_1 + 1}}}{2}$$

$$y(x) = -\frac{\sqrt{-2 + 2\sqrt{4x^4 + 4x^2 + 8c_1 + 1}}}{2}$$

$$y(x) = \frac{\sqrt{-2 + 2\sqrt{4x^4 + 4x^2 + 8c_1 + 1}}}{2}$$

✓ Solution by Mathematica

Time used: 2.324 (sec). Leaf size: 143

```
DSolve[(2*y[x]^3+y[x])*y'[x]-2*x^3-x==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -\frac{\sqrt{-1-\sqrt{(2x^2+1)^2+8c_1}}}{\sqrt{2}}$$
$$y(x) \to \frac{\sqrt{-1-\sqrt{(2x^2+1)^2+8c_1}}}{\sqrt{2}}$$
$$y(x) \to -\frac{\sqrt{-1+\sqrt{(2x^2+1)^2+8c_1}}}{\sqrt{2}}$$
$$y(x) \to \frac{\sqrt{-1+\sqrt{(2x^2+1)^2+8c_1}}}{\sqrt{2}}$$

6.50 problem Exercise 12.50, page 103

Internal problem ID [4062]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 2. Special types of differential equations of the first kind. Lesson 12, Miscellaneous Methods
Problem number: Exercise 12.50, page 103.
ODE order: 1.
ODE degree: 1.

CAS Maple gives this as type `[_separable]`

$$\boxed{y' - e^{-y+x} + e^{x} = 0}$$

✓ Solution by Maple

Time used: 0.125 (sec). Leaf size: 20

```
dsolve(diff(y(x),x)-exp(x-y(x))+exp(x)=0,y(x), singsol=all)
```

$$y(x) = -e^{x} + \ln\left(-1 + e^{e^{x}+c_1}\right) - c_1$$

✓ Solution by Mathematica

Time used: 2.145 (sec). Leaf size: 23

```
DSolve[y'[x]-Exp[x-y[x]]+Exp[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \log\left(1 + e^{-e^{x}+c_1}\right)$$
$$y(x) \to 0$$

7 Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients

7.1 problem Exercise 20.1, page 220

Internal problem ID [4063]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.1, page 220.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x]]`

$$\boxed{y'' + 2y' = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 12

```
dsolve(diff(y(x),x$2)+2*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = c_1 + c_2 e^{-2x}$$

✓ Solution by Mathematica

Time used: 0.01 (sec). Leaf size: 19

```
DSolve[y''[x]+2*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to c_2 - \frac{1}{2} c_1 e^{-2x}$$

7.2 problem Exercise 20.2, page 220

Internal problem ID [4064]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.2, page 220.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x]]`

$$\boxed{y'' - 3y' + 2y = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 15

```
dsolve(diff(y(x),x$2)-3*diff(y(x),x)+2*y(x)=0,y(x), singsol=all)
```

$$y(x) = c_1 \mathrm{e}^{x} + c_2 \mathrm{e}^{2x}$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 18

```
DSolve[y''[x]-3*y'[x]+2*y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^{x}(c_2 e^{x} + c_1)$$

7.3 problem Exercise 20.3, page 220

Internal problem ID [4065]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.3, page 220.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x]]`

$$\boxed{y'' - y = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 15

```
dsolve(diff(y(x),x$2)-y(x)=0,y(x), singsol=all)
```

$$y(x) = c_1 \mathrm{e}^{x} + c_2 \mathrm{e}^{-x}$$

✓ Solution by Mathematica

Time used: 0.002 (sec). Leaf size: 20

```
DSolve[y''[x]-y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to c_1 e^x + c_2 e^{-x}$$

7.4 problem Exercise 20.5, page 220

Internal problem ID [4066]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.5, page 220.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x]]`

$$\boxed{6y'' - 11y' + 4y = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 17

```
dsolve(6*diff(y(x),x$2)-11*diff(y(x),x)+4*y(x)=0,y(x), singsol=all)
```

$$y(x) = c_1 e^{\frac{4x}{3}} + c_2 e^{\frac{x}{2}}$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 35

```
DSolve[y''[x]-11*y'[x]+4*y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^{-\frac{1}{2}\left(\sqrt{105}-11\right)x}\left(c_2 e^{\sqrt{105}x} + c_1\right)$$

7.5 problem Exercise 20.6, page 220

Internal problem ID [4067]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.6, page 220.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x]]`

$$\boxed{y'' + 2y' - y = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 26

```
dsolve(diff(y(x),x$2)+2*diff(y(x),x)-y(x)=0,y(x), singsol=all)
```

$$y(x) = c_1 \mathrm{e}^{\left(\sqrt{2}-1\right)x} + c_2 \mathrm{e}^{-\left(1+\sqrt{2}\right)x}$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 34

```
DSolve[y''[x]+2*y'[x]-y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^{-\left(\left(1+\sqrt{2}\right)x\right)}\left(c_2 e^{2\sqrt{2}x} + c_1\right)$$

7.6 problem Exercise 20.7, page 220

Internal problem ID [4068]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.7, page 220.
ODE order: 3.
ODE degree: 1.

CAS Maple gives this as type `[[_3rd_order, _missing_x]]`

$$\boxed{y''' + y'' - 10y' - 6y = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 32

```
dsolve(diff(y(x),x$3)+diff(y(x),x$2)-10*diff(y(x),x)-6*y(x)=0,y(x), singsol=all)
```

$$y(x) = e^{3x}c_1 + c_2 e^{\left(-2+\sqrt{2}\right)x} + c_3 e^{-\left(2+\sqrt{2}\right)x}$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 43

```
DSolve[y'''[x]+y''[x]-10*y'[x]-6*y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to c_1 e^{-\left(\left(2+\sqrt{2}\right)x\right)} + c_2 e^{\left(\sqrt{2}-2\right)x} + c_3 e^{3x}$$

7.7 problem Exercise 20.8, page 220

Internal problem ID [4069]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.8, page 220.
ODE order: 4.
ODE degree: 1.

CAS Maple gives this as type `[[_high_order, _missing_x]]`

$$\boxed{y'''' - y''' - 4y'' + 4y' = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 22

```
dsolve(diff(y(x),x$4)-diff(y(x),x$3)-4*diff(y(x),x$2)+4*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = c_1 + e^x c_2 + c_3 e^{-2x} + c_4 e^{2x}$$

✓ Solution by Mathematica

Time used: 0.014 (sec). Leaf size: 36

```
DSolve[y''''[x]-y'''[x]-4*y''[x]+4*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \rightarrow -\frac{1}{2}c_1 e^{-2x} + c_2 e^x + \frac{1}{2}c_3 e^{2x} + c_4$$

7.8 problem Exercise 20.9, page 220

Internal problem ID [4070]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.9, page 220.
ODE order: 4.
ODE degree: 1.

CAS Maple gives this as type `[[_high_order, _missing_x]]`

$$\boxed{y'''' + 4y''' + y'' - 4y' - 2y = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 36

```
dsolve(diff(y(x),x$4)+4*diff(y(x),x$3)+diff(y(x),x$2)-4*diff(y(x),x)-2*y(x)=0,y(x), singsol=a
```

$$y(x) = c_1 e^x + c_2 e^{-x} + c_3 e^{\left(-2+\sqrt{2}\right)x} + c_4 e^{-\left(2+\sqrt{2}\right)x}$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 49

```
DSolve[y''''[x]+4*y'''[x]+y''[x]-4*y'[x]-2*y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to c_1 e^{-\left(\left(2+\sqrt{2}\right)x\right)} + c_2 e^{\left(\sqrt{2}-2\right)x} + c_3 e^{-x} + c_4 e^x$$

7.9 problem Exercise 20.10, page 220

Internal problem ID [4071]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.10, page 220.
ODE order: 4.
ODE degree: 1.

CAS Maple gives this as type `[[_high_order, _missing_x]]`

$$\boxed{y'''' - ya^2 = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 38

```
dsolve(diff(y(x),x$4)-a^2*y(x)=0,y(x), singsol=all)
```

$$y(x) = c_1 e^{\sqrt{a}\,x} + c_2 e^{-\sqrt{a}\,x} + c_3 \sin\left(\sqrt{a}\,x\right) + c_4 \cos\left(\sqrt{a}\,x\right)$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 53

```
DSolve[y''''[x]-a^2*y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to c_2 e^{-\sqrt{a}x} + c_4 e^{\sqrt{a}x} + c_1 \cos\left(\sqrt{a}x\right) + c_3 \sin\left(\sqrt{a}x\right)$$

7.10 problem Exercise 20.11, page 220

Internal problem ID [4072]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.11, page 220.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x]]`

$$\boxed{y'' - 2ky' - 2y = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 35

```
dsolve(diff(y(x),x$2)-2*k*diff(y(x),x)-2*y(x)=0,y(x), singsol=all)
```

$$y(x) = c_1 \mathrm{e}^{\left(k+\sqrt{k^2+2}\right)x} + c_2 \mathrm{e}^{\left(k-\sqrt{k^2+2}\right)x}$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 44

```
DSolve[y''[x]-2*k*y'[x]-2*y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to c_1 e^{\left(k-\sqrt{k^2+2}\right)x} + c_2 e^{\left(\sqrt{k^2+2}+k\right)x}$$

7.11 problem Exercise 20.12, page 220

Internal problem ID [4073]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.12, page 220.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x]]`

$$\boxed{y'' + 4ky' - 12k^2y = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 19

```
dsolve(diff(y(x),x$2)+4*k*diff(y(x),x)-12*k^2*y(x)=0,y(x), singsol=all)
```

$$y(x) = c_1 \mathrm{e}^{-6kx} + c_2 \mathrm{e}^{2kx}$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 24

```
DSolve[y''[x]+4*k*y'[x]-12*k^2*y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^{-6kx} \left(c_2 e^{8kx} + c_1\right)$$

7.12 problem Exercise 20.13, page 220

Internal problem ID [4074]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.13, page 220.
ODE order: 4.
ODE degree: 1.

CAS Maple gives this as type `[[_high_order, _quadrature]]`

$$\boxed{y'''' = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 21

```
dsolve(diff(y(x),x$4)=0,y(x), singsol=all)
```

$$y(x) = \frac{1}{6}c_1x^3 + \frac{1}{2}c_2x^2 + c_3x + c_4$$

✓ Solution by Mathematica

Time used: 0.002 (sec). Leaf size: 22

```
DSolve[y''''[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to x(x(c_4x + c_3) + c_2) + c_1$$

7.13 problem Exercise 20.14, page 220

Internal problem ID [4075]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.14, page 220.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x]]`

$$\boxed{y'' + 4y' + 4y = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 18

```
dsolve(diff(y(x),x$2)+4*diff(y(x),x)+4*y(x)=0,y(x), singsol=all)
```

$$y(x) = c_1 e^{-2x} + c_2 e^{-2x} x$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 18

```
DSolve[y''[x]+4*y'[x]+4*y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^{-2x}(c_2 x + c_1)$$

7.14 problem Exercise 20.15, page 220

Internal problem ID [4076]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.15, page 220.
ODE order: 3.
ODE degree: 1.

CAS Maple gives this as type `[[_3rd_order, _missing_x]]`

$$\boxed{3y''' + 5y'' + y' - y = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 24

```
dsolve(3*diff(y(x),x$3)+5*diff(y(x),x$2)+diff(y(x),x)-y(x)=0,y(x), singsol=all)
```

$$y(x) = c_1 e^{\frac{x}{3}} + c_2 e^{-x} + c_3 e^{-x} x$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 28

```
DSolve[3*y'''[x]+5*y''[x]+y'[x]-y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^{-x} \left(c_1 e^{4x/3} + c_3 x + c_2\right)$$

7.15 problem Exercise 20.16, page 220

Internal problem ID [4077]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.16, page 220.
ODE order: 3.
ODE degree: 1.

CAS Maple gives this as type `[[_3rd_order, _missing_x]]`

$$\boxed{y''' - 6y'' + 12y' - 8y = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 27

```
dsolve(diff(y(x),x$3)-6*diff(y(x),x$2)+12*diff(y(x),x)-8*y(x)=0,y(x), singsol=all)
```

$$y(x) = c_1 e^{2x} + c_2 e^{2x} x + c_3 e^{2x} x^2$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 23

```
DSolve[y'''[x]-6*y''[x]+12*y'[x]-8*y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^{2x}(x(c_3 x + c_2) + c_1)$$

7.16 problem Exercise 20.17, page 220

Internal problem ID [4078]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.17, page 220.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x]]`

$$\boxed{y'' - 2ay' + ya^2 = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 18

```
dsolve(diff(y(x),x$2)-2*a*diff(y(x),x)+a^2*y(x)=0,y(x), singsol=all)
```

$$y(x) = c_1 e^{ax} + c_2 e^{ax} x$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 18

```
DSolve[y''[x]-2*a*y'[x]+a^2*y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \rightarrow e^{ax}(c_2 x + c_1)$$

7.17 problem Exercise 20.18, page 220

Internal problem ID [4079]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.18, page 220.
ODE order: 4.
ODE degree: 1.

CAS Maple gives this as type `[[_high_order, _missing_x]]`

$$\boxed{y'''' + 3y''' = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 20

```
dsolve(diff(y(x),x$4)+3*diff(y(x),x$3)=0,y(x), singsol=all)
```

$$y(x) = c_1 + c_2x + c_3x^2 + c_4\mathrm{e}^{-3x}$$

✓ Solution by Mathematica

Time used: 0.027 (sec). Leaf size: 28

```
DSolve[y''''[x]+3*y'''[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -\frac{1}{27}c_1e^{-3x} + x(c_4x + c_3) + c_2$$

7.18 problem Exercise 20.19, page 220

Internal problem ID [4080]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.19, page 220.
ODE order: 4.
ODE degree: 1.

CAS Maple gives this as type `[[_high_order, _missing_x]]`

$$\boxed{y'''' - 2y'' = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 26

```
dsolve(diff(y(x),x$4)-2*diff(y(x),x$2)=0,y(x), singsol=all)
```

$$y(x) = c_1 + c_2x + c_3\mathrm{e}^{\sqrt{2}\,x} + c_4\mathrm{e}^{-\sqrt{2}\,x}$$

✓ Solution by Mathematica

Time used: 0.033 (sec). Leaf size: 42

```
DSolve[y''''[x]-2*y''[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{2}e^{-\sqrt{2}x}\left(c_1e^{2\sqrt{2}x} + c_2\right) + c_4x + c_3$$

7.19 problem Exercise 20.20, page 220

Internal problem ID [4081]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.20, page 220.
ODE order: 4.
ODE degree: 1.

CAS Maple gives this as type `[[_high_order, _missing_x]]`

$$\boxed{y'''' + 2y''' - 11y'' - 12y' + 36y = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 31

```
dsolve(diff(y(x),x$4)+2*diff(y(x),x$3)-11*diff(y(x),x$2)-12*diff(y(x),x)+36*y(x)=0,y(x), sing
```

$$y(x) = c_1 e^{-3x} + c_2 e^{-3x} x + c_3 e^{2x} + c_4 e^{2x} x$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 31

```
DSolve[y''''[x]+2*y'''[x]-11*y''[x]-12*y'[x]+36*y[x]==0,y[x],x,IncludeSingularSolutions -> Tr
```

$$y(x) \to e^{-3x}\left(c_2 x + e^{5x}(c_4 x + c_3) + c_1\right)$$

7.20 problem Exercise 20.21, page 220

Internal problem ID [4082]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.21, page 220.
ODE order: 4.
ODE degree: 1.

CAS Maple gives this as type `[[_high_order, _missing_x]]`

$$36y'''' - 37y'' + 4y' + 5y = 0$$

✓ Solution by Maple

Time used: 0.015 (sec). Leaf size: 29

```
dsolve(36*diff(y(x),x$4)-37*diff(y(x),x$2)+4*diff(y(x),x)+5*y(x)=0,y(x), singsol=all)
```

$$y(x) = c_1 e^{-x} + c_2 e^{\frac{x}{2}} + c_3 e^{-\frac{x}{3}} + c_4 e^{\frac{5x}{6}}$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 44

```
DSolve[36*y''''[x]-37*y''[x]+4*y'[x]+5*y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^{-x}\left(c_1 e^{11x/6} + c_2 e^{2x/3} + c_3 e^{3x/2} + c_4\right)$$

7.21 problem Exercise 20.22, page 220

Internal problem ID [4083]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.22, page 220.
ODE order: 4.
ODE degree: 1.

CAS Maple gives this as type `[[_high_order, _missing_x]]`

$$\boxed{y'''' - 8y'' + 36y = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 48

```
dsolve(diff(y(x),x$4)-8*diff(y(x),x$2)+36*y(x)=0,y(x), singsol=all)
```

$$y(x) = c_1 e^{\sqrt{5}\,x} \sin(x) - c_2 e^{-\sqrt{5}\,x} \sin(x) + c_3 e^{\sqrt{5}\,x} \cos(x) + c_4 e^{-\sqrt{5}\,x} \cos(x)$$

✓ Solution by Mathematica

Time used: 0.007 (sec). Leaf size: 49

```
DSolve[y''''[x]-8*y''[x]+36*y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^{-\sqrt{5}x}\left(c_2 \cos(x) + c_4 \sin(x) + e^{2\sqrt{5}x}(c_3 \cos(x) + c_1 \sin(x))\right)$$

7.22 problem Exercise 20.23, page 220

Internal problem ID [4084]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.23, page 220.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x]]`

$$\boxed{y'' - 2y' + 5y = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 21

```
dsolve(diff(y(x),x$2)-2*diff(y(x),x)+5*y(x)=0,y(x), singsol=all)
```

$$y(x) = c_1 e^x \sin(2x) + c_2 e^x \cos(2x)$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 24

```
DSolve[y''[x]-2*y'[x]+5*y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^x (c_2 \cos(2x) + c_1 \sin(2x))$$

7.23 problem Exercise 20.24, page 220

Internal problem ID [4085]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.24, page 220.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x]]`

$$\boxed{y'' - y' + y = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 31

```
dsolve(diff(y(x),x$2)-diff(y(x),x)+y(x)=0,y(x), singsol=all)
```

$$y(x) = c_1 e^{\frac{x}{2}} \sin\left(\frac{\sqrt{3}\,x}{2}\right) + c_2 e^{\frac{x}{2}} \cos\left(\frac{\sqrt{3}\,x}{2}\right)$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 42

```
DSolve[y''[x]-y'[x]+y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^{x/2}\left(c_1 \cos\left(\frac{\sqrt{3}x}{2}\right) + c_2 \sin\left(\frac{\sqrt{3}x}{2}\right)\right)$$

7.24 problem Exercise 20.25, page 220

Internal problem ID [4086]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.25, page 220.
ODE order: 4.
ODE degree: 1.

CAS Maple gives this as type `[[_high_order, _missing_x]]`

$$\boxed{y'''' + 5y'' + 6y = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 37

```
dsolve(diff(y(x),x$4)+5*diff(y(x),x$2)+6*y(x)=0,y(x), singsol=all)
```

$$y(x) = c_1 \sin\left(\sqrt{2}\,x\right) + c_2 \cos\left(\sqrt{2}\,x\right) + c_3 \sin\left(\sqrt{3}\,x\right) + c_4 \cos\left(\sqrt{3}\,x\right)$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 50

```
DSolve[y''''[x]+5*y''[x]+6*y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to c_3 \cos\left(\sqrt{2}x\right) + c_1 \cos\left(\sqrt{3}x\right) + c_4 \sin\left(\sqrt{2}x\right) + c_2 \sin\left(\sqrt{3}x\right)$$

7.25 problem Exercise 20.26, page 220

Internal problem ID [4087]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.26, page 220.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x]]`

$$\boxed{y'' - 4y' + 20y = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 25

```
dsolve(diff(y(x),x$2)-4*diff(y(x),x)+20*y(x)=0,y(x), singsol=all)
```

$$y(x) = c_1 e^{2x} \sin(4x) + c_2 e^{2x} \cos(4x)$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 26

```
DSolve[y''[x]-4*y'[x]+20*y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^{2x}(c_2 \cos(4x) + c_1 \sin(4x))$$

7.26 problem Exercise 20.27, page 220

Internal problem ID [4088]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.27, page 220.
ODE order: 4.
ODE degree: 1.

CAS Maple gives this as type `[[_high_order, _missing_x]]`

$$\boxed{y'''' + 4y'' + 4y = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 39

```
dsolve(diff(y(x),x$4)+4*diff(y(x),x$2)+4*y(x)=0,y(x), singsol=all)
```

$$y(x) = c_1 \sin\left(\sqrt{2}\,x\right) + c_2 \cos\left(\sqrt{2}\,x\right) + c_3 \sin\left(\sqrt{2}\,x\right) x + c_4 \cos\left(\sqrt{2}\,x\right) x$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 38

```
DSolve[y''''[x]+4*y''[x]+4*y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to (c_2 x + c_1) \cos\left(\sqrt{2}x\right) + (c_4 x + c_3) \sin\left(\sqrt{2}x\right)$$

7.27 problem Exercise 20.28, page 220

Internal problem ID [4089]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.28, page 220.
ODE order: 3.
ODE degree: 1.

CAS Maple gives this as type `[[_3rd_order, _missing_x]]`

$$\boxed{y''' + 8y = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 31

```
dsolve(diff(y(x),x$3)+8*y(x)=0,y(x), singsol=all)
```

$$y(x) = c_1 e^{-2x} + c_2 e^{x} \sin\left(\sqrt{3}\, x\right) + c_3 e^{x} \cos\left(\sqrt{3}\, x\right)$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 41

```
DSolve[y'''[x]+8*y[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to c_1 e^{-2x} + e^{x}\left(c_3 \cos\left(\sqrt{3}x\right) + c_2 \sin\left(\sqrt{3}x\right)\right)$$

7.28 problem Exercise 20.29, page 220

Internal problem ID [4090]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.29, page 220.
ODE order: 4.
ODE degree: 1.

CAS Maple gives this as type `[[_high_order, _missing_x]]`

$$\boxed{y'''' + 4y'' = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 21

```
dsolve(diff(y(x),x$4)+4*diff(y(x),x$2)=0,y(x), singsol=all)
```

$$y(x) = c_1 + c_2 x + c_3 \sin(2x) + c_4 \cos(2x)$$

✓ Solution by Mathematica

Time used: 0.057 (sec). Leaf size: 32

```
DSolve[y''''[x]+4*y''[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to c_4 x - \frac{1}{4} c_1 \cos(2x) - \frac{1}{4} c_2 \sin(2x) + c_3$$

7.29 problem Exercise 20.30, page 220

Internal problem ID [4091]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20.30, page 220.
ODE order: 5.
ODE degree: 1.

CAS Maple gives this as type `[[_high_order, _missing_x]]`

$$\boxed{y^{(5)} + 2y''' + y' = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 24

```
dsolve(diff(y(x),x$5)+2*diff(y(x),x$3)+diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = c_1 + c_2 \sin(x) + c_3 \cos(x) + c_4 \sin(x) x + c_5 \cos(x) x$$

✓ Solution by Mathematica

Time used: 0.052 (sec). Leaf size: 35

```
DSolve[y'''''[x]+2*y'''[x]+y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to (-c_4 x + c_2 - c_3)\cos(x) + (c_2 x + c_1 + c_4)\sin(x) + c_5$$

7.30 problem Exercise 20, problem 31, page 220

Internal problem ID [4092]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20, problem 31, page 220.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _quadrature]]`

$$\boxed{y'' = 0}$$

With initial conditions

$$[y(1) = 2, y'(1) = -1]$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 9

```
dsolve([diff(y(x),x$2)=0,y(1) = 2, D(y)(1) = -1],y(x), singsol=all)
```

$$y(x) = 3 - x$$

✓ Solution by Mathematica

Time used: 0.005 (sec). Leaf size: 10

```
DSolve[{y''[x]==0,{y[1]==2,y'[1]==-1}},y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to 3 - x$$

7.31 problem Exercise 20, problem 32, page 220

Internal problem ID [4093]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20, problem 32, page 220.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x]]`

$$\boxed{y'' + 4y' + 4y = 0}$$

With initial conditions

$$[y(0) = 1, y'(0) = 1]$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 14

```
dsolve([diff(y(x),x$2)+4*diff(y(x),x)+4*y(x)=0,y(0) = 1, D(y)(0) = 1],y(x), singsol=all)
```

$$y(x) = \mathrm{e}^{-2x}(3x + 1)$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 16

```
DSolve[{y''[x]+4*y'[x]+4*y[x]==0,{y[0]==1,y'[0]==1}},y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^{-2x}(3x + 1)$$

7.32 problem Exercise 20, problem 33, page 220

Internal problem ID [4094]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20, problem 33, page 220.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x]]`

$$\boxed{y'' - 2y' + 5y = 0}$$

With initial conditions

$$[y(0) = 2, y'(0) = 1]$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 21

```
dsolve([diff(y(x),x$2)-2*diff(y(x),x)+5*y(x)=0,y(0) = 2, D(y)(0) = 1],y(x), singsol=all)
```

$$y(x) = \frac{e^x(-\sin(2x) + 4\cos(2x))}{2}$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 25

```
DSolve[{y''[x]-2*y'[x]+5*y[x]==0,{y[0]==2,y'[0]==1}},y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{2}e^x(4\cos(2x) - \sin(2x))$$

7.33 problem Exercise 20, problem 34, page 220

Internal problem ID [4095]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20, problem 34, page 220.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x]]`

$$\boxed{y'' - 4y' + 20y = 0}$$

With initial conditions

$$\left[y\left(\frac{\pi}{2}\right) = 1, y'\left(\frac{\pi}{2}\right) = 1\right]$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 27

```
dsolve([diff(y(x),x$2)-4*diff(y(x),x)+20*y(x)=0,y(1/2*Pi) = 1, D(y)(1/2*Pi) = 1],y(x), singso
```

$$y(x) = \frac{(-\sin(4x) + 4\cos(4x))\, e^{2x-\pi}}{4}$$

✓ Solution by Mathematica

Time used: 0.004 (sec). Leaf size: 31

```
DSolve[{y''[x]-4*y'[x]+20*y[x]==0,{y[Pi/2]==1,y'[Pi/2]==1}},y[x],x,IncludeSingularSolutions -
```

$$y(x) \to \frac{1}{4} e^{2x-\pi}(4\cos(4x) - \sin(4x))$$

7.34 problem Exercise 20, problem 35, page 220

Internal problem ID [4096]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 20. Constant coefficients
Problem number: Exercise 20, problem 35, page 220.
ODE order: 3.
ODE degree: 1.

CAS Maple gives this as type `[[_3rd_order, _missing_x]]`

$$\boxed{3y''' + 5y'' + y' - y = 0}$$

With initial conditions

$$[y(0) = 0, y'(0) = 1, y''(0) = -1]$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 21

```
dsolve([3*diff(y(x),x$3)+5*diff(y(x),x$2)+diff(y(x),x)-y(x)=0,y(0) = 0, D(y)(0) = 1, (D@@2)(y
```

$$y(x) = \frac{\left(9\,\mathrm{e}^{\frac{4x}{3}} + 4x - 9\right)\mathrm{e}^{-x}}{16}$$

✓ Solution by Mathematica

Time used: 0.004 (sec). Leaf size: 28

```
DSolve[{3*y'''[x]+5*y''[x]+y'[x]-y[x]==0,{y[0]==0,y'[0]==1,y''[0]==-1}},y[x],x,IncludeSingula
```

$$y(x) \to \frac{1}{16}e^{-x}\left(4x + 9e^{4x/3} - 9\right)$$

8 Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients

8.1 problem Exercise 21.3, page 231

Internal problem ID [4097]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.3, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x]]`

$$\boxed{y'' + 3y' + 2y - 4 = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 19

```
dsolve(diff(y(x),x$2)+3*diff(y(x),x)+2*y(x)=4,y(x), singsol=all)
```

$$y(x) = -c_1 e^{-2x} + c_2 e^{-x} + 2$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 22

```
DSolve[y''[x]+3*y'[x]+2*y[x]==4,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to 2 + e^{-2x}(c_2 e^x + c_1)$$

8.2 problem Exercise 21.4, page 231

Internal problem ID [4098]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.4, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _with_linear_symmetries]]`

$$\boxed{y'' + 3y' + 2y - 12\,\mathrm{e}^{x} = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 22

```
dsolve(diff(y(x),x$2)+3*diff(y(x),x)+2*y(x)=12*exp(x),y(x), singsol=all)
```

$$y(x) = -c_1\mathrm{e}^{-2x} + 2\,\mathrm{e}^{x} + c_2\mathrm{e}^{-x}$$

✓ Solution by Mathematica

Time used: 0.004 (sec). Leaf size: 27

```
DSolve[y''[x]+3*y'[x]+2*y[x]==12*Exp[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^{-2x}\left(2e^{3x} + c_2e^{x} + c_1\right)$$

8.3 problem Exercise 21.5, page 231

Internal problem ID [4099]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.5, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _with_linear_symmetries]]`

$$\boxed{y'' + 3y' + 2y - e^{ix} = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 29

```
dsolve(diff(y(x),x$2)+3*diff(y(x),x)+2*y(x)=exp(I*x),y(x), singsol=all)
```

$$y(x) = \left(\left(\frac{1}{10} - \frac{3i}{10}\right) e^{ix+x} - c_1 e^{-x} + c_2\right) e^{-x}$$

✓ Solution by Mathematica

Time used: 0.018 (sec). Leaf size: 37

```
DSolve[y''[x]+3*y'[x]+2*y[x]==Exp[I*x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \left(\frac{1}{10} - \frac{3i}{10}\right) e^{ix} + c_1 e^{-2x} + c_2 e^{-x}$$

8.4 problem Exercise 21.6, page 231

Internal problem ID [4100]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.6, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' + 3y' + 2y - \sin(x) = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 26

```
dsolve(diff(y(x),x$2)+3*diff(y(x),x)+2*y(x)=sin(x),y(x), singsol=all)
```

$$y(x) = -c_1 e^{-2x} - \frac{3\cos(x)}{10} + \frac{\sin(x)}{10} + c_2 e^{-x}$$

✓ Solution by Mathematica

Time used: 0.018 (sec). Leaf size: 32

```
DSolve[y''[x]+3*y'[x]+2*y[x]==Sin[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{10}\left(\sin(x) - 3\cos(x) + 10e^{-2x}(c_2 e^{x} + c_1)\right)$$

8.5 problem Exercise 21.7, page 231

Internal problem ID [4101]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.7, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' + 3y' + 2y - \cos(x) = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 26

```
dsolve(diff(y(x),x$2)+3*diff(y(x),x)+2*y(x)=cos(x),y(x), singsol=all)
```

$$y(x) = -c_1 \mathrm{e}^{-2x} + \frac{\cos(x)}{10} + \frac{3\sin(x)}{10} + c_2 \mathrm{e}^{-x}$$

✓ Solution by Mathematica

Time used: 0.023 (sec). Leaf size: 32

```
DSolve[y''[x]+3*y'[x]+2*y[x]==Cos[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{10}\left(3\sin(x) + \cos(x) + 10e^{-2x}(c_2 e^x + c_1)\right)$$

8.6 problem Exercise 21.8, page 231

Internal problem ID [4102]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.8, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' + 3y' + 2y - 8 - 6\,\mathrm{e}^{x} - 2\sin(x) = 0}$$

✓ Solution by Maple

Time used: 0.015 (sec). Leaf size: 29

```
dsolve(diff(y(x),x$2)+3*diff(y(x),x)+2*y(x)=8+6*exp(x)+2*sin(x),y(x), singsol=all)
```

$$y(x) = -c_1\mathrm{e}^{-2x} + 4 + \mathrm{e}^{x} - \frac{3\cos(x)}{5} + \frac{\sin(x)}{5} + c_2\mathrm{e}^{-x}$$

✓ Solution by Mathematica

Time used: 0.078 (sec). Leaf size: 38

```
DSolve[y''[x]+3*y'[x]+2*y[x]==8+6*Exp[x]+2*Sin[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^{x} + \frac{\sin(x)}{5} - \frac{3\cos(x)}{5} + c_1e^{-2x} + c_2e^{-x} + 4$$

8.7 problem Exercise 21.9, page 231

Internal problem ID [4103]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.9, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _with_linear_symmetries]]`

$$\boxed{y'' + y' + y - x^2 = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 37

```
dsolve(diff(y(x),x$2)+diff(y(x),x)+y(x)=x^2,y(x), singsol=all)
```

$$y(x) = \mathrm{e}^{-\frac{x}{2}} \sin\left(\frac{\sqrt{3}\, x}{2}\right) c_2 + \mathrm{e}^{-\frac{x}{2}} \cos\left(\frac{\sqrt{3}\, x}{2}\right) c_1 + x^2 - 2x$$

✓ Solution by Mathematica

Time used: 0.004 (sec). Leaf size: 48

```
DSolve[y''[x]+y'[x]+y[x]==x^2,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to (x-2)x + e^{-x/2}\left(c_2 \cos\left(\frac{\sqrt{3}x}{2}\right) + c_1 \sin\left(\frac{\sqrt{3}x}{2}\right)\right)$$

8.8 problem Exercise 21.10, page 231

Internal problem ID [4104]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.10, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' - 2y' - 8y - 9\,\mathrm{e}^{x}x - 10\,\mathrm{e}^{-x} = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 28

```
dsolve(diff(y(x),x$2)-2*diff(y(x),x)-8*y(x)=9*x*exp(x)+10*exp(-x),y(x), singsol=all)
```

$$y(x) = \mathrm{e}^{4x}c_2 + c_1\mathrm{e}^{-2x} - \mathrm{e}^{x}x - 2\,\mathrm{e}^{-x}$$

✓ Solution by Mathematica

Time used: 0.068 (sec). Leaf size: 35

```
DSolve[y''[x]-2*y'[x]-8*y[x]==9*x*Exp[x]+10*Exp[-x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^{-2x}\left(-e^{3x}x - 2e^{x} + c_2e^{6x} + c_1\right)$$

8.9 problem Exercise 21.11, page 231

Internal problem ID [4105]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.11, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_y]]`

$$\boxed{y'' - 3y' - 2\,\mathrm{e}^{2x}\sin(x) = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 29

```
dsolve(diff(y(x),x$2)-3*diff(y(x),x)=2*exp(2*x)*sin(x),y(x), singsol=all)
```

$$y(x) = \frac{\mathrm{e}^{3x}c_1}{3} - \frac{\mathrm{e}^{2x}\cos(x)}{5} - \frac{3\,\mathrm{e}^{2x}\sin(x)}{5} + c_2$$

✓ Solution by Mathematica

Time used: 0.249 (sec). Leaf size: 33

```
DSolve[y''[x]-3*y'[x]==2*Exp[2*x]*Sin[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{15}e^{2x}(-9\sin(x) - 3\cos(x) + 5c_1e^x) + c_2$$

8.10 problem Exercise 21.13, page 231

Internal problem ID [4106]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.13, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_y]]`

$$\boxed{y'' + y' - x^2 - 2x = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 18

```
dsolve(diff(y(x),x$2)+diff(y(x),x)=x^2+2*x,y(x), singsol=all)
```

$$y(x) = \frac{x^3}{3} - c_1 \mathrm{e}^{-x} + c_2$$

✓ Solution by Mathematica

Time used: 0.036 (sec). Leaf size: 24

```
DSolve[y''[x]+y'[x]==x^2+2*x,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{x^3}{3} - c_1 e^{-x} + c_2$$

8.11 problem Exercise 21.14, page 231

Internal problem ID [4107]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.14, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_y]]`

$$\boxed{y'' + y' - x - \sin(2x) = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 33

```
dsolve(diff(y(x),x$2)+diff(y(x),x)=x+sin(2*x),y(x), singsol=all)
```

$$y(x) = \frac{x^2}{2} - c_1 \mathrm{e}^{-x} - \frac{\sin(2x)}{5} - \frac{\cos(2x)}{10} - x + c_2$$

✓ Solution by Mathematica

Time used: 0.367 (sec). Leaf size: 41

```
DSolve[y''[x]+y'[x]==x+Sin[2*x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{2}(x-2)x - \frac{1}{5}\sin(2x) - \frac{1}{10}\cos(2x) - c_1 e^{-x} + c_2$$

8.12 problem Exercise 21.15, page 231

Internal problem ID [4108]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.15, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' + y - 4\sin(x)\,x = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 25

```
dsolve(diff(y(x),x$2)+y(x)=4*x*sin(x),y(x), singsol=all)
```

$$y(x) = c_2 \sin(x) + c_1 \cos(x) - x(x\cos(x) - \sin(x))$$

✓ Solution by Mathematica

Time used: 0.019 (sec). Leaf size: 27

```
DSolve[y''[x]+y[x]==4*x*Sin[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \left(-x^2 + \frac{1}{2} + c_1\right)\cos(x) + (x + c_2)\sin(x)$$

8.13 problem Exercise 21.16, page 231

Internal problem ID [4109]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.16, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' + 4y - x \sin(2x) = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 33

```
dsolve(diff(y(x),x$2)+4*y(x)=x*sin(2*x),y(x), singsol=all)
```

$$y(x) = \sin(2x)\, c_2 + c_1 \cos(2x) + \frac{\sin(2x)\, x}{16} - \frac{x^2 \cos(2x)}{8}$$

✓ Solution by Mathematica

Time used: 0.019 (sec). Leaf size: 38

```
DSolve[y''[x]+4*y[x]==x*Sin[2*x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{64}\left(\left(-8x^2 + 1 + 64c_1\right)\cos(2x) + 4(x + 16c_2)\sin(2x)\right)$$

8.14 problem Exercise 21.17, page 231

Internal problem ID [4110]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.17, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' + 2y' + y - x^2 \mathrm{e}^{-x} = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 27

```
dsolve(diff(y(x),x$2)+2*diff(y(x),x)+y(x)=x^2*exp(-x),y(x), singsol=all)
```

$$y(x) = c_2 \mathrm{e}^{-x} + \mathrm{e}^{-x} c_1 x + \frac{x^4 \mathrm{e}^{-x}}{12}$$

✓ Solution by Mathematica

Time used: 0.008 (sec). Leaf size: 27

```
DSolve[y''[x]+2*y'[x]+y[x]==x^2*Exp[-x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{12} e^{-x} \left(x^4 + 12c_2 x + 12c_1\right)$$

8.15 problem Exercise 21.19, page 231

Internal problem ID [4111]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.19, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' + 3y' + 2y - e^{-2x} - x^2 = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 40

```
dsolve(diff(y(x),x$2)+3*diff(y(x),x)+2*y(x)=exp(-2*x)+x^2,y(x), singsol=all)
```

$$y(x) = -c_1 e^{-2x} - \frac{3x}{2} + \frac{7}{4} - x\, e^{-2x} - e^{-2x} + \frac{x^2}{2} + c_2 e^{-x}$$

✓ Solution by Mathematica

Time used: 0.035 (sec). Leaf size: 38

```
DSolve[y''[x]+3*y'[x]+2*y[x]==Exp[-2*x]+x^2,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{2}(x-3)x + e^{-2x}(-x-1+c_1) + c_2 e^{-x} + \frac{7}{4}$$

8.16 problem Exercise 21.20, page 231

Internal problem ID [4112]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.20, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' - 3y' + 2y - \mathrm{e}^{-x}x = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 26

```
dsolve(diff(y(x),x$2)-3*diff(y(x),x)+2*y(x)=x*exp(-x),y(x), singsol=all)
```

$$y(x) = \left(c_1\mathrm{e}^{x} + \frac{5\,\mathrm{e}^{-2x}}{36} + \frac{x\,\mathrm{e}^{-2x}}{6} + c_2\right)\mathrm{e}^{x}$$

✓ Solution by Mathematica

Time used: 0.006 (sec). Leaf size: 34

```
DSolve[y''[x]-3*y'[x]+2*y[x]==x*Exp[-x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{36}e^{-x}(6x+5) + c_1e^{x} + c_2e^{2x}$$

8.17 problem Exercise 21.21, page 231

Internal problem ID [4113]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.21, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _with_linear_symmetries]]`

$$\boxed{y'' + y' - 6y - x - e^{2x} = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 32

```
dsolve(diff(y(x),x$2)+diff(y(x),x)-6*y(x)=x+exp(2*x),y(x), singsol=all)
```

$$y(x) = e^{-3x}c_2 + c_1e^{2x} - \frac{1}{36} + \frac{(-1+5x)\,e^{2x}}{25} - \frac{x}{6}$$

✓ Solution by Mathematica

Time used: 0.039 (sec). Leaf size: 40

```
DSolve[y''[x]+y'[x]-6*y[x]==x+Exp[2*x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{36}(-6x-1) + c_1e^{-3x} + e^{2x}\left(\frac{x}{5} - \frac{1}{25} + c_2\right)$$

8.18 problem Exercise 21.22, page 231

Internal problem ID [4114]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.22, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' + y - \sin(x) - e^{-x} = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 24

```
dsolve(diff(y(x),x$2)+y(x)=sin(x)+exp(-x),y(x), singsol=all)
```

$$y(x) = c_2 \sin(x) + c_1 \cos(x) + \frac{e^{-x}}{2} - \frac{x\cos(x)}{2}$$

✓ Solution by Mathematica

Time used: 0.169 (sec). Leaf size: 36

```
DSolve[y''[x]+y[x]==Sin[x]+Exp[-x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{4}\left(2e^{-x} + \sin(x) - 2x\cos(x) + 4c_1\cos(x) + 4c_2\sin(x)\right)$$

8.19 problem Exercise 21.24, page 231

Internal problem ID [4115]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.24, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' + y - \sin(x)^2 = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 20

```
dsolve(diff(y(x),x$2)+y(x)=sin(x)^2,y(x), singsol=all)
```

$$y(x) = c_2 \sin(x) + c_1 \cos(x) + \frac{1}{2} + \frac{\cos(2x)}{6}$$

✓ Solution by Mathematica

Time used: 0.015 (sec). Leaf size: 27

```
DSolve[y''[x]+y[x]==Sin[x]^2,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{6}(\cos(2x) + 6c_1 \cos(x) + 6c_2 \sin(x) + 3)$$

8.20 problem Exercise 21.27, page 231

Internal problem ID [4116]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.27, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' + y - \sin(2x)\sin(x) = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 25

```
dsolve(diff(y(x),x$2)+y(x)=sin(2*x)*sin(x),y(x), singsol=all)
```

$$y(x) = c_2 \sin(x) + c_1 \cos(x) + \frac{\sin(x)(-\cos(x)\sin(x) + x)}{4}$$

✓ Solution by Mathematica

Time used: 0.014 (sec). Leaf size: 33

```
DSolve[y''[x]+y[x]==Sin[2*x]*Sin[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{16}(\cos(3x) + (-1 + 16c_1)\cos(x) + 4(x + 4c_2)\sin(x))$$

8.21 problem Exercise 21.28, page 231

Internal problem ID [4117]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.28, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _with_linear_symmetries]]`

$$\boxed{y'' - 5y' - 6y - e^{3x} = 0}$$

With initial conditions

$$[y(0) = 2, y'(0) = 1]$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 23

```
dsolve([diff(y(x),x$2)-5*diff(y(x),x)-6*y(x)=exp(3*x),y(0) = 2, D(y)(0) = 1],y(x), singsol=al
```

$$y(x) = \frac{45\,e^{-x}}{28} + \frac{10\,e^{6x}}{21} - \frac{e^{3x}}{12}$$

✓ Solution by Mathematica

Time used: 0.009 (sec). Leaf size: 30

```
DSolve[{y''[x]-5*y'[x]-6*y[x]==Exp[3*x],{y[0]==2,y'[0]==1}},y[x],x,IncludeSingularSolutions -
```

$$y(x) \to \frac{1}{84}e^{-x}\left(-7e^{4x} + 40e^{7x} + 135\right)$$

8.22 problem Exercise 21.29, page 231

Internal problem ID [4118]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.29, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' - y' - 2y - 5\sin(x) = 0}$$

With initial conditions

$$[y(0) = 1, y'(0) = -1]$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 25

```
dsolve([diff(y(x),x$2)-diff(y(x),x)-2*y(x)=5*sin(x),y(0) = 1, D(y)(0) = -1],y(x), singsol=all
```

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

✓ Solution by Mathematica

Time used: 0.007 (sec). Leaf size: 30

```
DSolve[{y''[x]-y'[x]-2*y[x]==5*Sin[x],{y[0]==1,y'[0]==-1}},y[x],x,IncludeSingularSolutions ->
```

$$y(x) \to \frac{1}{6}\left(e^{-x} + 2e^{2x} - 9\sin(x) + 3\cos(x)\right)$$

8.23 problem Exercise 21.31, page 231

Internal problem ID [4119]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.31, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' + 9y - 8\cos(x) = 0}$$

With initial conditions

$$\left[y\left(\frac{\pi}{2}\right) = -1, y'\left(\frac{\pi}{2}\right) = 1\right]$$

✓ Solution by Maple

Time used: 0.031 (sec). Leaf size: 17

```
dsolve([diff(y(x),x$2)+9*y(x)=8*cos(x),y(1/2*Pi) = -1, D(y)(1/2*Pi) = 1],y(x), singsol=all)
```

$$y(x) = \sin(3x) + \frac{2\cos(3x)}{3} + \cos(x)$$

✓ Solution by Mathematica

Time used: 0.005 (sec). Leaf size: 20

```
DSolve[{y''[x]+9*y[x]==8*Cos[x],{y[Pi/2]==-1,y'[Pi/2]==1}},y[x],x,IncludeSingularSolutions ->
```

$$y(x) \to \sin(3x) + \cos(x) + \frac{2}{3}\cos(3x)$$

8.24 problem Exercise 21.32, page 231

Internal problem ID [4120]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.32, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' - 5y' + 6y - e^{x}(2x - 3) = 0}$$

With initial conditions

$$[y(0) = 1, y'(0) = 3]$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 13

```
dsolve([diff(y(x),x$2)-5*diff(y(x),x)+6*y(x)=exp(x)*(2*x-3),y(0) = 1, D(y)(0) = 3],y(x), sing
```

$$y(x) = e^{2x} + e^{x}x$$

✓ Solution by Mathematica

Time used: 0.006 (sec). Leaf size: 35

```
DSolve[{y''[x]-5*y'[x]-6*y[x]==Exp[x]*(2*x-3),{y[0]==1,y'[0]==3}},y[x],x,IncludeSingularSolut
```

$$y(x) \to \frac{1}{175}e^{-x}\left(-7e^{2x}(5x - 9) + 87e^{7x} + 25\right)$$

8.25 problem Exercise 21.33, page 231

Internal problem ID [4121]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 21. Undetermined Coefficients
Problem number: Exercise 21.33, page 231.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _with_linear_symmetries]]`

$$\boxed{y'' - 3y' + 2y - e^{-x} = 0}$$

With initial conditions

$$[y(0) = 1, y'(0) = -1]$$

✓ Solution by Maple

Time used: 0.031 (sec). Leaf size: 21

```
dsolve([diff(y(x),x$2)-3*diff(y(x),x)+2*y(x)=exp(-x),y(0) = 1, D(y)(0) = -1],y(x), singsol=al
```

$$y(x) = -\frac{5\,e^{2x}}{3} + \frac{5\,e^{x}}{2} + \frac{e^{-x}}{6}$$

✓ Solution by Mathematica

Time used: 0.008 (sec). Leaf size: 30

```
DSolve[{y''[x]-3*y'[x]+2*y[x]==Exp[-x],{y[0]==1,y'[0]==-1}},y[x],x,IncludeSingularSolutions -
```

$$y(x) \to \frac{1}{3}(7\sinh(x) - 5\sinh(2x) + 8\cosh(x) - 5\cosh(2x))$$

9 Chapter 4. Higher order linear differential equations. Lesson 22. Variation of Parameters

9.1 problem Exercise 22.1, page 240

Internal problem ID [4122]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 22. Variation of Parameters
Problem number: Exercise 22.1, page 240.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' + y - \sec(x) = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 24

```
dsolve(diff(y(x),x$2)+y(x)=sec(x),y(x), singsol=all)
```

$$y(x) = c_2 \sin(x) + c_1 \cos(x) + x \sin(x) - \ln(\sec(x)) \cos(x)$$

✓ Solution by Mathematica

Time used: 0.008 (sec). Leaf size: 22

```
DSolve[y''[x]+y[x]==Sec[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to (x + c_2) \sin(x) + \cos(x)(\log(\cos(x)) + c_1)$$

9.2 problem Exercise 22.2, page 240

Internal problem ID [4123]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 22. Variation of Parameters
Problem number: Exercise 22.2, page 240.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' + y - \cot(x) = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 24

```
dsolve(diff(y(x),x$2)+y(x)=cot(x),y(x), singsol=all)
```

$$y(x) = c_2 \sin(x) + c_1 \cos(x) + \sin(x) \ln(\csc(x) - \cot(x))$$

✓ Solution by Mathematica

Time used: 0.013 (sec). Leaf size: 33

```
DSolve[y''[x]+y[x]==Cot[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to c_1 \cos(x) + \sin(x) \left(\log\left(\sin\left(\frac{x}{2}\right)\right) - \log\left(\cos\left(\frac{x}{2}\right)\right) + c_2\right)$$

9.3 problem Exercise 22.3, page 240

Internal problem ID [4124]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 22. Variation of Parameters
Problem number: Exercise 22.3, page 240.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' + y - \sec(x)^2 = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 23

```
dsolve(diff(y(x),x$2)+y(x)=sec(x)^2,y(x), singsol=all)
```

$$y(x) = c_2 \sin(x) + c_1 \cos(x) + \ln(\sec(x) + \tan(x)) \sin(x) - 1$$

✓ Solution by Mathematica

Time used: 0.014 (sec). Leaf size: 27

```
DSolve[y''[x]+y[x]==Sec[x]^2,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \sin(x) \left(2\text{arctanh}\left(\tan\left(\frac{x}{2}\right)\right) + c_2\right) + c_1 \cos(x) - 1$$

9.4 problem Exercise 22.4, page 240

Internal problem ID [4125]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 22. Variation of Parameters
Problem number: Exercise 22.4, page 240.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' - y - \sin(x)^2 = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 22

```
dsolve(diff(y(x),x$2)-y(x)=sin(x)^2,y(x), singsol=all)
```

$$y(x) = \mathrm{e}^{x} c_2 + c_1 \mathrm{e}^{-x} + \frac{\cos(x)^2}{5} - \frac{3}{5}$$

✓ Solution by Mathematica

Time used: 0.022 (sec). Leaf size: 30

```
DSolve[y''[x]-y[x]==Sin[x]^2,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{10}(\cos(2x) - 5) + c_1 e^{x} + c_2 e^{-x}$$

9.5 problem Exercise 22.5, page 240

Internal problem ID [4126]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 22. Variation of Parameters
Problem number: Exercise 22.5, page 240.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' + y - \sin(x)^2 = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 20

```
dsolve(diff(y(x),x$2)+y(x)=sin(x)^2,y(x), singsol=all)
```

$$y(x) = c_2 \sin(x) + c_1 \cos(x) + \frac{1}{2} + \frac{\cos(2x)}{6}$$

✓ Solution by Mathematica

Time used: 0.007 (sec). Leaf size: 27

```
DSolve[y''[x]+y[x]==Sin[x]^2,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{6}(\cos(2x) + 6c_1 \cos(x) + 6c_2 \sin(x) + 3)$$

9.6 problem Exercise 22.6, page 240

Internal problem ID [4127]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 22. Variation of Parameters
Problem number: Exercise 22.6, page 240.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _with_linear_symmetries]]`

$$\boxed{y'' + 3y' + 2y - 12\,\mathrm{e}^{x} = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 22

```
dsolve(diff(y(x),x$2)+3*diff(y(x),x)+2*y(x)=12*exp(x),y(x), singsol=all)
```

$$y(x) = -c_1\mathrm{e}^{-2x} + 2\,\mathrm{e}^{x} + c_2\mathrm{e}^{-x}$$

✓ Solution by Mathematica

Time used: 0.003 (sec). Leaf size: 27

```
DSolve[y''[x]+3*y'[x]+2*y[x]==12*Exp[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^{-2x}\left(2e^{3x} + c_2e^{x} + c_1\right)$$

9.7 problem Exercise 22.7, page 240

Internal problem ID [4128]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 22. Variation of Parameters
Problem number: Exercise 22.7, page 240.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' + 2y' + y - x^2 e^{-x} = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 27

```
dsolve(diff(y(x),x$2)+2*diff(y(x),x)+y(x)=x^2*exp(-x),y(x), singsol=all)
```

$$y(x) = c_2 e^{-x} + e^{-x} c_1 x + \frac{x^4 e^{-x}}{12}$$

✓ Solution by Mathematica

Time used: 0.005 (sec). Leaf size: 27

```
DSolve[y''[x]+2*y'[x]+y[x]==x^2*Exp[-x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{12} e^{-x} (x^4 + 12 c_2 x + 12 c_1)$$

9.8 problem Exercise 22.8, page 240

Internal problem ID [4129]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 22. Variation of Parameters
Problem number: Exercise 22.8, page 240.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' + y - 4\sin(x)\, x = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 25

```
dsolve(diff(y(x),x$2)+y(x)=4*x*sin(x),y(x), singsol=all)
```

$$y(x) = c_2 \sin(x) + c_1 \cos(x) - x(x\cos(x) - \sin(x))$$

✓ Solution by Mathematica

Time used: 0.008 (sec). Leaf size: 27

```
DSolve[y''[x]+y[x]==4*x*Sin[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \left(-x^2 + \frac{1}{2} + c_1\right)\cos(x) + (x + c_2)\sin(x)$$

9.9 problem Exercise 22.9, page 240

Internal problem ID [4130]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 22. Variation of Parameters
Problem number: Exercise 22.9, page 240.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' + 2y' + y - e^{-x} \ln(x) = 0}$$

✓ Solution by Maple

Time used: 0.015 (sec). Leaf size: 33

```
dsolve(diff(y(x),x$2)+2*diff(y(x),x)+y(x)=exp(-x)*ln(x),y(x), singsol=all)
```

$$y(x) = c_2 e^{-x} + e^{-x} c_1 x + \frac{x^2 (2 \ln(x) - 3) e^{-x}}{4}$$

✓ Solution by Mathematica

Time used: 0.007 (sec). Leaf size: 36

```
DSolve[y''[x]+2*y'[x]+y[x]==Exp[-x]*Log[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{4} e^{-x} \left(-3x^2 + 2x^2 \log(x) + 4c_2 x + 4c_1\right)$$

9.10 problem Exercise 22.10, page 240

Internal problem ID [4131]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 22. Variation of Parameters
Problem number: Exercise 22.10, page 240.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' + y - \csc(x) = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 25

```
dsolve(diff(y(x),x$2)+y(x)=csc(x),y(x), singsol=all)
```

$$y(x) = c_2 \sin(x) + c_1 \cos(x) - \ln(\csc(x)) \sin(x) - x \cos(x)$$

✓ Solution by Mathematica

Time used: 0.007 (sec). Leaf size: 27

```
DSolve[y''[x]+y[x]==Csc[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to (-x + c_1)\cos(x) + \sin(x)(\log(\tan(x)) + \log(\cos(x)) + c_2)$$

9.11 problem Exercise 22.11, page 240

Internal problem ID [4132]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 22. Variation of Parameters
Problem number: Exercise 22.11, page 240.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' + y - \tan(x)^2 = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 23

```
dsolve(diff(y(x),x$2)+y(x)=tan(x)^2,y(x), singsol=all)
```

$$y(x) = c_2 \sin(x) + c_1 \cos(x) - 2 + \ln(\sec(x) + \tan(x)) \sin(x)$$

✓ Solution by Mathematica

Time used: 0.052 (sec). Leaf size: 21

```
DSolve[y''[x]+y[x]==Tan[x]^2,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \sin(x)(\operatorname{arctanh}(\sin(x)) + c_2) + c_1 \cos(x) - 2$$

9.12 problem Exercise 22.12, page 240

Internal problem ID [4133]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 22. Variation of Parameters
Problem number: Exercise 22.12, page 240.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' + 2y' + y - \frac{\mathrm{e}^{-x}}{x} = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 28

```
dsolve(diff(y(x),x$2)+2*diff(y(x),x)+y(x)=exp(-x)/x,y(x), singsol=all)
```

$$y(x) = c_2\mathrm{e}^{-x} + \mathrm{e}^{-x}c_1x + x(\ln(x) - 1)\,\mathrm{e}^{-x}$$

✓ Solution by Mathematica

Time used: 0.006 (sec). Leaf size: 24

```
DSolve[y''[x]+2*y'[x]+y[x]==Exp[-x]/x,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^{-x}(x\log(x) + (-1 + c_2)x + c_1)$$

9.13 problem Exercise 22.13, page 240

Internal problem ID [4134]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 22. Variation of Parameters
Problem number: Exercise 22.13, page 240.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' + y - \sec(x)\csc(x) = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 34

```
dsolve(diff(y(x),x$2)+y(x)=sec(x)*csc(x),y(x), singsol=all)
```

$$y(x) = c_2 \sin(x) + c_1 \cos(x) + \sin(x)\ln(\csc(x) - \cot(x)) - \ln(\sec(x) + \tan(x))\cos(x)$$

✓ Solution by Mathematica

Time used: 0.012 (sec). Leaf size: 39

```
DSolve[y''[x]+y[x]==Sec[x]*Csc[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \cos(x)(-\text{arctanh}(\sin(x)) + c_1) + \sin(x)\left(\log\left(\sin\left(\frac{x}{2}\right)\right) - \log\left(\cos\left(\frac{x}{2}\right)\right) + c_2\right)$$

9.14 problem Exercise 22.14, page 240

Internal problem ID [4135]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 22. Variation of Parameters
Problem number: Exercise 22.14, page 240.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' - 2y' + y - e^x \ln(x) = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 27

```
dsolve(diff(y(x),x$2)-2*diff(y(x),x)+y(x)=exp(x)*ln(x),y(x), singsol=all)
```

$$y(x) = e^x c_2 + e^x c_1 x + \frac{e^x x^2 (2\ln(x) - 3)}{4}$$

✓ Solution by Mathematica

Time used: 0.006 (sec). Leaf size: 34

```
DSolve[y''[x]-2*y'[x]+y[x]==Exp[x]*Log[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{4} e^x \left(-3x^2 + 2x^2 \log(x) + 4c_2 x + 4c_1\right)$$

9.15 problem Exercise 22.15, page 240

Internal problem ID [4136]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 22. Variation of Parameters
Problem number: Exercise 22.15, page 240.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _linear, _nonhomogeneous]]`

$$\boxed{y'' - 3y' + 2y - \cos\left(e^{-x}\right) = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 26

```
dsolve(diff(y(x),x$2)-3*diff(y(x),x)+2*y(x)=cos(exp(-x)),y(x), singsol=all)
```

$$y(x) = \left(c_1 e^x - e^x - e^x \cos\left(e^{-x}\right) + c_2\right) e^x$$

✓ Solution by Mathematica

Time used: 0.036 (sec). Leaf size: 27

```
DSolve[y''[x]-3*y'[x]+2*y[x]==Cos[Exp[-x]],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^x \left(e^x \left(-\cos\left(e^{-x}\right) + c_2\right) + c_1\right)$$

9.16 problem Exercise 22, problem 16, page 240

Internal problem ID [4137]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 22. Variation of Parameters
Problem number: Exercise 22, problem 16, page 240.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _with_linear_symmetries]]`

$$\boxed{x^2y'' - y'x + y - x = 0}$$

✓ Solution by Maple

Time used: 0.015 (sec). Leaf size: 20

```
dsolve(x^2*diff(y(x),x$2)-x*diff(y(x),x)+y(x)=x,y(x), singsol=all)
```

$$y(x) = c_2x + x\ln(x)\,c_1 + \frac{\ln(x)^2\,x}{2}$$

✓ Solution by Mathematica

Time used: 0.007 (sec). Leaf size: 25

```
DSolve[x^2*y''[x]-x*y'[x]+y[x]==x,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{2}x\left(\log^2(x) + 2c_2\log(x) + 2c_1\right)$$

9.17 problem Exercise 22, problem 17, page 240

Internal problem ID [4138]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 22. Variation of Parameters
Problem number: Exercise 22, problem 17, page 240.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _exact, _linear, _nonhomogeneous]]`

$$\boxed{y'' - \frac{2y'}{x} + \frac{2y}{x^2} - \ln(x)\,x = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 24

```
dsolve(diff(y(x),x$2)-2/x*diff(y(x),x)+2/x^2*y(x)=x*ln(x),y(x), singsol=all)
```

$$y(x) = c_1 x + c_2 x^2 + \frac{x^3(2\ln(x) - 3)}{4}$$

✓ Solution by Mathematica

Time used: 0.004 (sec). Leaf size: 32

```
DSolve[y''[x]-2/x*y'[x]+2/x^2*y[x]==x*Log[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{4}x\left(-3x^2 + 2x^2\log(x) + 4c_2 x + 4c_1\right)$$

9.18 problem Exercise 22, problem 18, page 240

Internal problem ID [4139]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 22. Variation of Parameters
Problem number: Exercise 22, problem 18, page 240.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _with_linear_symmetries]]`

$$\boxed{x^2y'' + y'x - 4y - x^3 = 0}$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 20

```
dsolve(x^2*diff(y(x),x$2)+x*diff(y(x),x)-4*y(x)=x^3,y(x), singsol=all)
```

$$y(x) = \frac{c_2}{x^2} + c_1x^2 + \frac{x^3}{5}$$

✓ Solution by Mathematica

Time used: 0.004 (sec). Leaf size: 25

```
DSolve[x^2*y''[x]+x*y'[x]-4*y[x]==x^3,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{x^3}{5} + c_2x^2 + \frac{c_1}{x^2}$$

9.19 problem Exercise 22, problem 19, page 240

Internal problem ID [4140]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 22. Variation of Parameters
Problem number: Exercise 22, problem 19, page 240.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _exact, _linear, _nonhomogeneous]]`

$$\boxed{x^2y'' + y'x - y - x^2\mathrm{e}^{-x} = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 24

```
dsolve(x^2*diff(y(x),x$2)+x*diff(y(x),x)-y(x)=x^2*exp(-x),y(x), singsol=all)
```

$$y(x) = \frac{c_1}{x} + c_2x + \frac{\mathrm{e}^{-x}(x+1)}{x}$$

✓ Solution by Mathematica

Time used: 0.009 (sec). Leaf size: 27

```
DSolve[x^2*y''[x]+x*y'[x]-y[x]==x^2*Exp[-x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{c_2x^2 + e^{-x}(x+1) + c_1}{x}$$

9.20 problem Exercise 22, problem 20, page 240

Internal problem ID [4141]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 4. Higher order linear differential equations. Lesson 22. Variation of Parameters
Problem number: Exercise 22, problem 20, page 240.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _exact, _linear, _nonhomogeneous]]`

$$\boxed{2x^2y'' + 3y'x - y - \frac{1}{x} = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 26

```
dsolve(2*x^2*diff(y(x),x$2)+3*x*diff(y(x),x)-y(x)=1/x,y(x), singsol=all)
```

$$y(x) = \frac{c_1}{x} + c_2\sqrt{x} - \frac{3\ln(x) + 2}{9x}$$

✓ Solution by Mathematica

Time used: 0.005 (sec). Leaf size: 31

```
DSolve[2*x^2*y''[x]+3*x*y'[x]-y[x]==1/x,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{9c_2x^{3/2} - 3\log(x) - 2 + 9c_1}{9x}$$

10 Chapter 8. Special second order equations. Lesson 35. Independent variable x absent

10.1 problem Exercise 35.1, page 504

Internal problem ID [4142]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.1, page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x], [_2nd_order, _exact, _nonlinear], _L`

$$\boxed{y'' - 2yy' = 0}$$

✓ Solution by Maple

Time used: 0.078 (sec). Leaf size: 16

```
dsolve(diff(y(x),x$2)=2*y(x)*diff(y(x),x),y(x), singsol=all)
```

$$y(x) = \frac{\tan\left(\frac{c_2+x}{c_1}\right)}{c_1}$$

✓ Solution by Mathematica

Time used: 0.025 (sec). Leaf size: 24

```
DSolve[y''[x]==2*y[x]*y'[x],y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \sqrt{c_1} \tan\left(\sqrt{c_1}(x + c_2)\right)$$

10.2 problem Exercise 35.2, page 504

Internal problem ID [4143]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.2, page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x], [_2nd_order, _reducible, _mu_x_y1]]`

$$\boxed{y^3y'' - k = 0}$$

✓ Solution by Maple

Time used: 0.141 (sec). Leaf size: 70

```
dsolve(y(x)^3*diff(y(x),x$2)=k,y(x), singsol=all)
```

$$y(x) = \frac{\sqrt{c_1 \left(c_1^2 c_2^2 + 2c_1^2 c_2 x + c_1^2 x^2 + k\right)}}{c_1}$$
$$y(x) = -\frac{\sqrt{c_1 \left(c_1^2 c_2^2 + 2c_1^2 c_2 x + c_1^2 x^2 + k\right)}}{c_1}$$

✓ Solution by Mathematica

Time used: 0.986 (sec). Leaf size: 58

```
DSolve[y[x]^3*y''[x]==k,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \rightarrow -\frac{\sqrt{k + {c_1}^2 (x + c_2)^2}}{\sqrt{c_1}}$$
$$y(x) \rightarrow \frac{\sqrt{k + {c_1}^2 (x + c_2)^2}}{\sqrt{c_1}}$$

10.3 problem Exercise 35.3, page 504

Internal problem ID [4144]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.3, page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x], [_2nd_order, _reducible, _mu_x_y1]]`

$$\boxed{yy'' - y'^2 + 1 = 0}$$

✓ Solution by Maple

Time used: 0.14 (sec). Leaf size: 79

```
dsolve(y(x)*diff(y(x),x$2)=(diff(y(x),x))^2-1,y(x), singsol=all)
```

$$y(x) = \frac{c_1 \left(e^{-\frac{2c_2}{c_1}} e^{-\frac{2x}{c_1}} - 1\right) e^{\frac{c_2}{c_1}} e^{\frac{x}{c_1}}}{2}$$
$$y(x) = \frac{c_1 \left(e^{\frac{2c_2}{c_1}} e^{\frac{2x}{c_1}} - 1\right) e^{-\frac{c_2}{c_1}} e^{-\frac{x}{c_1}}}{2}$$

✓ Solution by Mathematica

Time used: 0.197 (sec). Leaf size: 85

```
DSolve[y[x]*y''[x]==(y'[x])^2-1,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -\frac{ie^{-c_1} \tanh\left(e^{c_1}(x + c_2)\right)}{\sqrt{-\text{sech}^2\left(e^{c_1}(x + c_2)\right)}}$$
$$y(x) \to \frac{ie^{-c_1} \tanh\left(e^{c_1}(x + c_2)\right)}{\sqrt{-\text{sech}^2\left(e^{c_1}(x + c_2)\right)}}$$

10.4 problem Exercise 35.4, page 504

Internal problem ID [4145]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.4, page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_y]]`

$$\boxed{x^2y'' + y'x - 1 = 0}$$

✓ Solution by Maple

Time used: 0.015 (sec). Leaf size: 16

```
dsolve(x^2*diff(y(x),x$2)+x*(diff(y(x),x))=1,y(x), singsol=all)
```

$$y(x) = \frac{\ln(x)^2}{2} + c_1 \ln(x) + c_2$$

✓ Solution by Mathematica

Time used: 0.011 (sec). Leaf size: 21

```
DSolve[x^2*y''[x]+x*y'[x]==1,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{\log^2(x)}{2} + c_1 \log(x) + c_2$$

10.5 problem Exercise 35.5, page 504

Internal problem ID [4146]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.5, page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_y]]`

$$\boxed{xy'' - y' - x^2 = 0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 17

```
dsolve(x*diff(y(x),x$2)-diff(y(x),x)=x^2,y(x), singsol=all)
```

$$y(x) = \frac{1}{3}x^3 + \frac{1}{2}c_1x^2 + c_2$$

✓ Solution by Mathematica

Time used: 0.026 (sec). Leaf size: 23

```
DSolve[x*y''[x]-y'[x]==x^2,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{6}x^2(2x + 3c_1) + c_2$$

10.6 problem Exercise 35.6, page 504

Internal problem ID [4147]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.6, page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x], _Liouville, [_2nd_order, _reducible,`

$$(1+y)\,y'' - 3y'^2 = 0$$

✓ Solution by Maple

Time used: 0.063 (sec). Leaf size: 59

```
dsolve((y(x)+1)*diff(y(x),x$2)=3*(diff(y(x),x))^2,y(x), singsol=all)
```

$$y(x) = -1$$
$$y(x) = -\frac{\sqrt{-2c_1x - 2c_2} - 1}{\sqrt{-2c_1x - 2c_2}}$$
$$y(x) = -\frac{\sqrt{-2c_1x - 2c_2} + 1}{\sqrt{-2c_1x - 2c_2}}$$

✓ Solution by Mathematica

Time used: 0.092 (sec). Leaf size: 58

```
DSolve[(y[x]+1)*y''[x]==3*(y'[x])^2,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{2}\left(-2 + \frac{\sqrt{2}}{\sqrt{-c_1(x + c_2)}}\right)$$
$$y(x) \to \frac{1}{2}\left(-2 - \frac{\sqrt{2}}{\sqrt{-c_1(x + c_2)}}\right)$$

10.7 problem Exercise 35.7, page 504

Internal problem ID [4148]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.7, page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x], [_2nd_order, _reducible, _mu_x_y1]]`

$$\boxed{r'' + \frac{k}{r^2} = 0}$$

✓ Solution by Maple

Time used: 0.062 (sec). Leaf size: 369

```
dsolve(diff(r(t),t$2)=-k/(r(t)^2),r(t), singsol=all)
```

$$r(t) = \frac{c_1\left(c_1^2k^2 - 2kc_1 e^{\mathrm{RootOf}\left(\mathrm{csgn}\left(\frac{1}{c_1}\right)c_1^4k^2 + 2\_Z c_1^3 k\,\mathrm{e}^{\_Z} - \mathrm{csgn}\left(\frac{1}{c_1}\right)\mathrm{e}^{2\_Z}c_1^2 - 2\,\mathrm{csgn}\left(\frac{1}{c_1}\right)\mathrm{e}^{\_Z}c_2 - 2\,\mathrm{csgn}\left(\frac{1}{c_1}\right)\mathrm{e}^{\_Z}t\right)} + e^{2\,\mathrm{RootOf}\left(\mathrm{csgn}\left(\frac{1}{c_1}\right.\right.}\right.}{}$$

$$r(t) = \frac{c_1\left(c_1^2k^2 - 2kc_1 e^{\mathrm{RootOf}\left(\mathrm{csgn}\left(\frac{1}{c_1}\right)c_1^4k^2 + 2\_Z c_1^3 k\,\mathrm{e}^{\_Z} - \mathrm{csgn}\left(\frac{1}{c_1}\right)\mathrm{e}^{2\_Z}c_1^2 + 2\,\mathrm{csgn}\left(\frac{1}{c_1}\right)\mathrm{e}^{\_Z}c_2 + 2\,\mathrm{csgn}\left(\frac{1}{c_1}\right)\mathrm{e}^{\_Z}t\right)} + e^{2\,\mathrm{RootOf}\left(\mathrm{csgn}\left(\frac{1}{c_1}\right.\right.}\right.}{}$$

✓ Solution by Mathematica

Time used: 0.165 (sec). Leaf size: 65

```
DSolve[r''[t]==-k/(r[t]^2),r[t],t,IncludeSingularSolutions -> True]
```

$$\text{Solve}\left[\left(\frac{r(t)\sqrt{\frac{2k}{r(t)} + c_1}}{c_1} - \frac{2k\operatorname{arctanh}\left(\frac{\sqrt{\frac{2k}{r(t)} + c_1}}{\sqrt{c_1}}\right)}{c_1{}^{3/2}}\right)^2 = (t + c_2)^2, r(t)\right]$$

10.8 problem Exercise 35.8, page 504

Internal problem ID [4149]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.8, page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x], [_2nd_order, _reducible, _mu_x_y1]]`

$$\boxed{y'' - \frac{3k y^2}{2} = 0}$$

✓ Solution by Maple

Time used: 0.047 (sec). Leaf size: 15

```
dsolve(diff(y(x),x$2)=3/2*k*y(x)^2,y(x), singsol=all)
```

$$y(x) = \frac{4 \operatorname{WeierstrassP}(x + c_1, 0, c_2)}{k}$$

✓ Solution by Mathematica

Time used: 0.045 (sec). Leaf size: 36

```
DSolve[y''[x]==3/2*(k*y[x]^2),y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{2^{2/3} \wp\left(\frac{\sqrt[3]{k}(x+c_1)}{2^{2/3}}; 0, c_2\right)}{\sqrt[3]{k}}$$

10.9 problem Exercise 35.9, page 504

Internal problem ID [4150]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.9, page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x], [_2nd_order, _reducible, _mu_x_y1]]`

$$\boxed{y'' - 2k y^3 = 0}$$

✓ Solution by Maple

Time used: 0.032 (sec). Leaf size: 20

```
dsolve(diff(y(x),x$2)=2*k*y(x)^3,y(x), singsol=all)
```

$$y(x) = c_2 \operatorname{JacobiSN}\left(\left(\sqrt{-k}\, x + c_1\right) c_2, i\right)$$

✓ Solution by Mathematica

Time used: 1.122 (sec). Leaf size: 115

```
DSolve[y''[x]==2*k*y[x]^3,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -\frac{i \operatorname{sn}\left((-1)^{3/4} \sqrt{\sqrt{k}\sqrt{c_1}(x+c_2)^2} \middle| -1\right)}{\sqrt{\frac{i\sqrt{k}}{\sqrt{c_1}}}}$$

$$y(x) \to \frac{i \operatorname{sn}\left((-1)^{3/4} \sqrt{\sqrt{k}\sqrt{c_1}(x+c_2)^2} \middle| -1\right)}{\sqrt{\frac{i\sqrt{k}}{\sqrt{c_1}}}}$$

10.10 problem Exercise 35.10, page 504

Internal problem ID [4151]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.10, page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x], [_2nd_order, _exact, _nonlinear], [_`

$$\boxed{yy'' + y'^2 - y' = 0}$$

✓ Solution by Maple

Time used: 0.125 (sec). Leaf size: 37

```
dsolve(y(x)*diff(y(x),x$2)+(diff(y(x),x))^2-diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = 0$$
$$y(x) = -c_1 \left(\text{LambertW}\left(-\frac{\mathrm{e}^{-1} \mathrm{e}^{-\frac{c_2}{c_1}} \mathrm{e}^{-\frac{x}{c_1}}}{c_1}\right) + 1\right)$$

✓ Solution by Mathematica

Time used: 0.088 (sec). Leaf size: 32

```
DSolve[y[x]*y''[x]+(y'[x])^2-y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -c_1 \left(1 + W\left(-\frac{e^{-\frac{x+c_1+c_2}{c_1}}}{c_1}\right)\right)$$

10.11 problem Exercise 35.11, page 504

Internal problem ID [4152]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.11, page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x], [_2nd_order, _reducible, _mu_x_y1]]`

$$r'' - \frac{h^2}{r^3} + \frac{k}{r^2} = 0$$

✓ Solution by Maple

Time used: 0.047 (sec). Leaf size: 441

```
dsolve(diff(r(t),t$2)= h^2/r(t)^3-k/r(t)^2,r(t), singsol=all)
```

$$r(t) = \frac{c_1\left(c_1^2k^2 - 2kc_1\mathrm{e}^{\mathrm{RootOf}\left(\mathrm{csgn}\left(\frac{1}{c_1}\right)c_1^4k^2+2\_Zc_1^3k\,\mathrm{e}^{-\_Z}-\mathrm{csgn}\left(\frac{1}{c_1}\right)\mathrm{e}^{2\_Z}c_1^2+\mathrm{csgn}\left(\frac{1}{c_1}\right)c_1^2h^2-2\,\mathrm{csgn}\left(\frac{1}{c_1}\right)\mathrm{e}^{\_Z}c_2-2\,\mathrm{csgn}\left(\frac{1}{c_1}\right)\mathrm{e}^{\_Z}t\right)} + \mathrm{e}^{2\,\mathrm{R}}\right.}{}$$

$$r(t) = \frac{c_1\left(c_1^2k^2 - 2kc_1\mathrm{e}^{\mathrm{RootOf}\left(\mathrm{csgn}\left(\frac{1}{c_1}\right)c_1^4k^2+2\_Zc_1^3k\,\mathrm{e}^{-\_Z}-\mathrm{csgn}\left(\frac{1}{c_1}\right)\mathrm{e}^{2\_Z}c_1^2+\mathrm{csgn}\left(\frac{1}{c_1}\right)c_1^2h^2+2\,\mathrm{csgn}\left(\frac{1}{c_1}\right)\mathrm{e}^{\_Z}c_2+2\,\mathrm{csgn}\left(\frac{1}{c_1}\right)\mathrm{e}^{\_Z}t\right)} + \mathrm{e}^{2\,\mathrm{R}}\right.}{}$$

✓ Solution by Mathematica

Time used: 1.074 (sec). Leaf size: 130

```
DSolve[r''[t]==h^2/r[t]^3-k/r[t]^2,r[t],t,IncludeSingularSolutions -> True]
```

$$\text{Solve}\left[\frac{\left(\sqrt{c_1}(-h^2+r(t)(2k+c_1r(t))) - k\sqrt{-h^2+r(t)(2k+c_1r(t))}\,\mathrm{arctanh}\left(\frac{k+c_1r(t)}{\sqrt{c_1}\sqrt{-h^2+r(t)(2k+c_1r(t))}}\right)\right)^2}{{c_1}^3r(t)^2\left(-\frac{h^2}{r(t)^2}+\frac{2k}{r(t)}+c_1\right)} = (\right.$$

$$\left. + c_2)^2, r(t)\right]$$

10.12 problem Exercise 35.12, page 504

Internal problem ID [4153]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.12, page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x], [_2nd_order, _reducible, _mu_x_y1],`

$$yy'' + y'^3 - y'^2 = 0$$

✓ Solution by Maple

Time used: 0.125 (sec). Leaf size: 44

```
dsolve(y(x)*diff(y(x),x$2)+(diff(y(x),x))^3-diff(y(x),x)^2=0,y(x), singsol=all)
```

$$y(x) = 0$$
$$y(x) = c_1$$
$$y(x) = \mathrm{e}^{-\frac{c_1 \operatorname{LambertW}\left(\frac{\mathrm{e}^{\frac{c_2}{c_1}} \mathrm{e}^{\frac{x}{c_1}}}{c_1}\right) - c_2 - x}{c_1}}$$

✓ Solution by Mathematica

Time used: 0.11 (sec). Leaf size: 29

```
DSolve[y[x]*y''[x]+(y'[x])^3-(y'[x])^2==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to e^{c_1} W\left(e^{e^{-c_1}(x+c_2)-c_1}\right)$$

10.13 problem Exercise 35.13, page 504

Internal problem ID [4154]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.13, page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x], _Liouville, [_2nd_order, _reducible,`

$$\boxed{yy'' - 3{y'}^2 = 0}$$

✓ Solution by Maple

Time used: 0.11 (sec). Leaf size: 33

```
dsolve(y(x)*diff(y(x),x$2)-3*(diff(y(x),x))^2=0,y(x), singsol=all)
```

$$y(x) = 0$$
$$y(x) = \frac{1}{\sqrt{-2c_1x - 2c_2}}$$
$$y(x) = -\frac{1}{\sqrt{-2c_1x - 2c_2}}$$

✓ Solution by Mathematica

Time used: 0.022 (sec). Leaf size: 14

```
DSolve[y[x]*y''[x]-(y'[x])^2==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to c_2 e^{c_1 x}$$

10.14 problem Exercise 35.14, page 504

Internal problem ID [4155]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.14, page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_y], [_2nd_order, _reducible, _mu_y_y1]]`

$$(x^2+1)\,y''+y'^2+1=0$$

✓ Solution by Maple

Time used: 0.047 (sec). Leaf size: 29

```
dsolve((1+x^2)*diff(y(x),x$2)+(diff(y(x),x))^2+1=0,y(x), singsol=all)
```

$$y(x)=\frac{x}{c_1}-\frac{(-c_1^2-1)\ln(c_1x-1)}{c_1^2}+c_2$$

✓ Solution by Mathematica

Time used: 7.102 (sec). Leaf size: 33

```
DSolve[(1+x^2)*y''[x]+(y'[x])^2+1==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x)\to -x\cot(c_1)+\csc^2(c_1)\log(-x\sin(c_1)-\cos(c_1))+c_2$$

10.15 problem Exercise 35.15, page 504

Internal problem ID [4156]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.15, page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_y]]`

$$\boxed{(x^2+1)\,y''+2x(y'+1)=0}$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 15

```
dsolve((1+x^2)*diff(y(x),x$2)+2*x*(diff(y(x),x)+1)=0,y(x), singsol=all)
```

$$y(x)=-x+(c_1+1)\arctan(x)+c_2$$

✓ Solution by Mathematica

Time used: 0.038 (sec). Leaf size: 18

```
DSolve[(1+x^2)*y''[x]+2*x*(y'[x]+1)==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x)\to(1+c_1)\arctan(x)-x+c_2$$

10.16 problem Exercise 35.16, page 504

Internal problem ID [4157]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.16, page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x], _Liouville, [_2nd_order, _reducible,`

$$\boxed{(1+y)\,y''-3y'^2=0}$$

With initial conditions

$$\left[y(1)=0,y'(1)=-\frac{1}{2}\right]$$

✓ Solution by Maple

Time used: 0.375 (sec). Leaf size: 15

```
dsolve([(y(x)+1)*diff(y(x),x$2)=3*(diff(y(x),x))^2,y(1) = 0, D(y)(1) = -1/2],y(x), singsol=al
```

$$y(x)=\frac{-x+\sqrt{x}}{x}$$

✗ Solution by Mathematica

Time used: 0.0 (sec). Leaf size: 0

```
DSolve[{(y[x]+1)*y''[x]==3*(y'[x])^3,{y[1]==0,y'[0]==-1/2}},y[x],x,IncludeSingularSolutions -
```

{}

10.17 problem Exercise 35.17, page 504

Internal problem ID [4158]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.17, page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x], [_2nd_order, _exact, _nonlinear], [_`

$$\boxed{y'' - y' e^{y} = 0}$$

With initial conditions

$$[y(3) = 0, y'(3) = 1]$$

✓ Solution by Maple

Time used: 0.078 (sec). Leaf size: 12

```
dsolve([diff(y(x),x$2)=diff(y(x),x)*exp(y(x)),y(3) = 0, D(y)(3) = 1],y(x), singsol=all)
```

$$y(x) = -\ln(-x + 4)$$

✗ Solution by Mathematica

Time used: 0.0 (sec). Leaf size: 0

```
DSolve[{y''[x]==y'[x]*Exp[y[x]],{y[3]==0,y'[3]==1}},y[x],x,IncludeSingularSolutions -> True]
```

{}

10.18 problem Exercise 35.18, page 504

Internal problem ID [4159]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.18, page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x], [_2nd_order, _exact, _nonlinear], _L`

$$\boxed{y'' - 2yy' = 0}$$

With initial conditions

$$[y(0) = 1, y'(0) = 2]$$

✓ Solution by Maple

Time used: 0.109 (sec). Leaf size: 10

```
dsolve([diff(y(x),x$2)=2*y(x)*diff(y(x),x),y(0) = 1, D(y)(0) = 2],y(x), singsol=all)
```

$$y(x) = \tan\left(x + \frac{\pi}{4}\right)$$

✗ Solution by Mathematica

Time used: 0.0 (sec). Leaf size: 0

```
DSolve[{y''[x]==2*y[x]*y'[x],{y[0]==1,y'[0]==2}},y[x],x,IncludeSingularSolutions -> True]
```

{}

10.19 problem Exercise 35.19, page 504

Internal problem ID [4160]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.19, page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_x], [_2nd_order, _reducible, _mu_x_y1]]`

$$2y'' - e^y = 0$$

With initial conditions

$$[y(0) = 0, y'(0) = 1]$$

✓ Solution by Maple

Time used: 0.062 (sec). Leaf size: 15

```
dsolve([2*diff(y(x),x$2)=exp(y(x)),y(0) = 0, D(y)(0) = 1],y(x), singsol=all)
```

$$y(x) = 2\ln(2) + \ln\left(\frac{1}{(x-2)^2}\right)$$

✓ Solution by Mathematica

Time used: 0.045 (sec). Leaf size: 15

```
DSolve[{2*y''[x]==Exp[y[x]],{y[0]==0,y'[0]==1}},y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to -2\log\left(1 - \frac{x}{2}\right)$$

10.20 problem Exercise 35.20, page 504

Internal problem ID [4161]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.20, page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_y]]`

$$\boxed{x^2y'' + y'x - 1 = 0}$$

With initial conditions

$$[y(1) = 1, y'(1) = 2]$$

✓ Solution by Maple

Time used: 0.0 (sec). Leaf size: 16

```
dsolve([x^2*diff(y(x),x$2)+x*diff(y(x),x)=1,y(1) = 1, D(y)(1) = 2],y(x), singsol=all)
```

$$y(x) = \frac{\ln(x)^2}{2} + 2\ln(x) + 1$$

✓ Solution by Mathematica

Time used: 0.013 (sec). Leaf size: 17

```
DSolve[{x^2*y''[x]+x*y'[x]==1,{y[1]==1,y'[1]==2}},y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{2}\log(x)(\log(x) + 4) + 1$$

10.21 problem Exercise 35.21, page 504

Internal problem ID [4162]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.21, page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _missing_y]]`

$$\boxed{xy'' - y' - x^2 = 0}$$

With initial conditions

$$[y(1) = 0, y'(1) = -1]$$

✓ Solution by Maple

Time used: 0.016 (sec). Leaf size: 16

```
dsolve([x*diff(y(x),x$2)-diff(y(x),x)=x^2,y(1) = 0, D(y)(1) = -1],y(x), singsol=all)
```

$$y(x) = \frac{1}{3}x^3 - x^2 + \frac{2}{3}$$

✓ Solution by Mathematica

Time used: 0.027 (sec). Leaf size: 18

```
DSolve[{x*y''[x]-y'[x]==x^2,{y[1]==0,y'[1]==-1}},y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{1}{3}\left((x-3)x^2 + 2\right)$$

10.22 problem Exercise 35.23(a), page 504

Internal problem ID [4163]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.23(a), page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[_Liouville, [_2nd_order, _with_linear_symmetries], [_2nd_order`

$$xyy'' - 2xy'^2 + yy' = 0$$

✓ Solution by Maple

Time used: 0.125 (sec). Leaf size: 18

```
dsolve(x*y(x)*diff(y(x),x$2)-2*x*(diff(y(x),x))^2+y(x)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = 0$$
$$y(x) = -\frac{1}{c_1 \ln(x) + c_2}$$

✓ Solution by Mathematica

Time used: 0.119 (sec). Leaf size: 17

```
DSolve[x*y[x]*y''[x]-2*x*(y'[x])^2+y[x]*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{c_2}{-\log(x) + c_1}$$

10.23 problem Exercise 35.23(b), page 504

Internal problem ID [4164]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.23(b), page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _exact, _nonlinear], _Liouville, [_2nd_order, _wi`

$$xyy'' + xy'^2 - yy' = 0$$

✓ Solution by Maple

Time used: 0.11 (sec). Leaf size: 35

```
dsolve(x*y(x)*diff(y(x),x$2)+x*(diff(y(x),x))^2-y(x)*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = 0$$
$$y(x) = \sqrt{c_1x^2 + 2c_2}$$
$$y(x) = -\sqrt{c_1x^2 + 2c_2}$$

✓ Solution by Mathematica

Time used: 0.097 (sec). Leaf size: 18

```
DSolve[x*y[x]*y''[x]+x*(y'[x])^2-y[x]*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to c_2\sqrt{x^2 + c_1}$$

10.24 problem Exercise 35.23(c), page 504

Internal problem ID [4165]

Book: Ordinary Differential Equations, By Tenenbaum and Pollard. Dover, NY 1963
Section: Chapter 8. Special second order equations. Lesson 35. Independent variable x absent
Problem number: Exercise 35.23(c), page 504.
ODE order: 2.
ODE degree: 1.

CAS Maple gives this as type `[[_2nd_order, _with_linear_symmetries], [_2nd_order, _reducible`

$$x y y'' - 2 x y'^2 + (1 + y) y' = 0$$

✓ Solution by Maple

Time used: 0.204 (sec). Leaf size: 22

```
dsolve(x*y(x)*diff(y(x),x$2)-2*x*(diff(y(x),x))^2+(1+y(x))*diff(y(x),x)=0,y(x), singsol=all)
```

$$y(x) = 0$$
$$y(x) = c_1 \tanh\left(\frac{\ln(x) - c_2}{2c_1}\right)$$

✓ Solution by Mathematica

Time used: 0.046 (sec). Leaf size: 37

```
DSolve[x*y[x]*y''[x]-2*x*(y'[x])^2+(1+y[x])*y'[x]==0,y[x],x,IncludeSingularSolutions -> True]
```

$$y(x) \to \frac{\tan\left(\frac{\sqrt{c_1}(\log(x) - c_2)}{\sqrt{2}}\right)}{\sqrt{2}\sqrt{c_1}}$$