```
> (D@D)(x)(t)
```

$$\mathrm{D}^{(2)}(x)(t) \tag{1}$$

1.
a)

```
> ec:=diff(x(t),t$2)+w0*w0*x(t)=0
```

$$ec := \frac{\mathrm{d}^2}{\mathrm{d}t^2} x(t) + w0^2\, x(t) = 0 \tag{2}$$

```
> dsolve(ec,x(t))
Error, (in dsolve) x(t) and x cannot both appear in the given ODE.
> dsolve(ec,x(t))
Error, (in dsolve) x(t) and x cannot both appear in the given ODE.
> dsolve(x)
Error, (in dsolve) expecting an ODE or a set or list of ODEs.
Received x
> dsolve(ec)
Error, (in dsolve) x(t) and x cannot both appear in the given ODE.
> with(DETools)
```

[*AreSimilar*, *Closure*, *DEnormal*, *DEplot*, *DEplot3d*, *DEplot_polygon*, *DFactor*, *DFactorLCLM*, *DFactorsols*, *Dchangevar*, *Desingularize*, *FindODE*, *FunctionDecomposition*, *GCRD*, *Gosper*, *Heunsols*, *Homomorphisms*, *IVPsol*, *IsHyperexponential*, *LCLM*, *MeijerGsols*, *MultiplicativeDecomposition*, *ODEInvariants*, *PDEchangecoords*, *PolynomialNormalForm*, *RationalCanonicalForm*, *ReduceHyperexp*, *RiemannPsols*, *Xchange*, *Xcommutator*, *Xgauge*, *Zeilberger*, *abelsol*, *adjoint*, *autonomous*, *bernoullisol*, *buildsol*, *buildsym*, *canoni*, *caseplot*, *casesplit*, *checkrank*, *chinisol*, *clairautsol*, *constcoeffsols*, *convertAlg*, *convertsys*, *dalembertsol*, *dcoeffs*, *de2diffop*, *dfieldplot*, *diff_table*, *diffop2de*, *dperiodic_sols*, *dpolyform*, *dsubs*, *eigenring*, *endomorphism_charpoly*, *equinv*, *eta_k*, *eulersols*, *exactsol*, *expsols*, *exterior_power*, *firint*, *firtest*, *formal_sol*, *gen_exp*, *generate_ic*, *genhomosol*, *gensys*, *hamilton_eqs*, *hypergeometricsols*, *hypergeomsols*, *hyperode*, *indicialeq*, *infgen*, *initialdata*, *integrate_sols*, *intfactor*, *invariants*, *kovacicsols*, *leftdivision*, *liesol*, *line_int*, *linearsol*, *matrixDE*, *matrix_riccati*, *maxdimsystems*, *moser_reduce*, *muchange*, *mult*, *mutest*, *newton_polygon*, *normalG2*, *ode_int_y*, *ode_y1*, *odeadvisor*, *odepde*, *parametricsol*, *particularsol*, *phaseportrait*, *poincare*, *polysols*, *power_equivalent*, *rational_equivalent*, *ratsols*, *redode*, *reduceOrder*, *reduce_order*, *regular_parts*, *regularsp*, *remove_RootOf*, *riccati_system*, *riccatisol*, *rifread*, *rifsimp*, *rightdivision*, *rtaylor*, *separablesol*, *singularities*, *solve_group*, *super_reduce*, *symgen*, *symmetric_power*, *symmetric_product*, *symtest*, *transinv*, *translate*, *untranslate*, *varparam*, *zoom*] **(3)**

```
> dsolve(ec,x(t))
```

$$x(t) = c_1 \sin(w0\, t) + c_2 \cos(w0\, t) \tag{4}$$

```
> dsolve(ec,x(t))
```

$$x(t) = c_1 \sin(w0\, t) + c_2 \cos(w0\, t) \tag{5}$$

```
> rez:=dsolve(ec,x(t))
```

(6)

$$rez := x(t) = c_1 \sin(w0\,t) + c_2 \cos(w0\,t) \tag{6}$$

b)

```
> ysol:=unapply(rhs(rez), t, w0, _C1, _C2)
```

$$ysol := (t, w0, c_1, c_2) \mapsto c_1 \cdot \sin(t \cdot w0) + c_2 \cdot \cos(t \cdot w0) \tag{7}$$

```
> subs(_C1=R*cos(d),_C2=R*sin(d),rez)
```

$$x(t) = R \cos(d)\, \sin(w0\,t) + R \sin(d)\, \cos(w0\,t) \tag{8}$$

```
> combine(ysol(t,w0,R*cos(d),R*sin(d)))
```

$$R \sin(w0\,t + d) \tag{9}$$

c)

```
> ecsol:=dsolve({ec, x(0)=x0, D(x)(0)=v0}, x(t))
```

$$ecsol := x(t) = \frac{v0 \sin(w0\,t)}{w0} + x0 \cos(w0\,t) \tag{10}$$

```
> ec2:=R*cos(d)=v0/w0
```

$$ec2 := R \cos(d) = \frac{v0}{w0} \tag{11}$$

```
> ec3:=R*sin(d)=x0
```

$$ec3 := R \sin(d) = x0 \tag{12}$$

```
> solve({ec2,ec3},{R,d})
```

$$\left\{R = \frac{RootOf\left(-x0^2\, w0^2 + \_Z^2 - v0^2\right)}{w0},\ d = \arctan\left(\frac{x0\, w0}{RootOf\left(-x0^2\, w0^2 + \_Z^2 - v0^2\right)},\ \frac{v0}{RootOf\left(-x0^2\, w0^2 + \_Z^2 - v0^2\right)}\right)\right\} \tag{13}$$

```
> allvalues(%)
```

$$\left\{R = \frac{\sqrt{x0^2\, w0^2 + v0^2}}{w0},\ d = \arctan\left(\frac{x0\, w0}{\sqrt{x0^2\, w0^2 + v0^2}},\ \frac{v0}{\sqrt{x0^2\, w0^2 + v0^2}}\right)\right\},\ \left\{R = -\frac{\sqrt{x0^2\, w0^2 + v0^2}}{w0},\ d = \arctan\left(-\frac{x0\, w0}{\sqrt{x0^2\, w0^2 + v0^2}},\ -\frac{v0}{\sqrt{x0^2\, w0^2 + v0^2}}\right)\right\} \tag{14}$$

```
> ysol((2*pi)/w0, w0,
```

d)

```
> expr:=sqrt(w0^2*39.24^2 + 0^2)/w0=15
```

$$expr := \frac{39.24000000\, \sqrt{w0^2}}{w0} = 15 \tag{15}$$

```
> solve(expr,w0)
> w0:=sqrt(9.81/0.3924)
```

$$w0 := 5.000000000 \tag{16}$$

```
> x0:=0.15
```

$$x0 := 0.15 \tag{17}$$

```
> v0:=0
```

$$v0 := 0 \tag{18}$$

```
> d:=arctan(x0*w0/sqrt(w0^2*x0^2 + v0^2), v0/sqrt(w0^2*x0^2 + v0^2)
  )
```

$$d := \arctan\left(\frac{1.000000000\ w0}{\sqrt{w0^2}}, 0\right) \tag{19}$$

```
> d:=arctan(x0*w0/sqrt(w0^2*x0^2 + v0^2), v0/sqrt(w0^2*x0^2 + v0^2)
  )
```

$$d := 1.570796327 \tag{20}$$