```
eq := diff(u(x), x$2) - 3·diff(u(x), x) = 9 · x - 5;
```

$$\frac{d^2}{dx^2} u(x) - 3 \left(\frac{d}{dx} u(x) \right) = 9x - 5 \quad (1)$$

```
#a
sol := dsolve(eq, u(x));
```

$$u(x) = -\frac{3}{2} x^2 + \frac{1}{3} e^{3x} \_C1 + \frac{2}{3} x + \_C2 \quad (2)$$

```
#b
f := unapply(rhs(sol), x);
```

$$x \rightarrow -\frac{3}{2} x^2 + \frac{1}{3} e^{3x} \_C1 + \frac{2}{3} x + \_C2$$

```
expr := subs(_C1 = 0, _C2 = 0, f(x));
```

$$-\frac{3}{2} x^2 + \frac{2}{3} x \quad (4)$$

```
limit(expr, x = infinity);
```

$$-\infty \quad (5)$$

```
#c
ics := u(0) = 0, D(u)(0) = 1;
```

$$u(0) = 0, D(u)(0) = 1 \quad (6)$$

```
sol := dsolve({eq, ics}, u(x));
```

$$u(x) = -\frac{3}{2} x^2 + \frac{1}{9} e^{3x} + \frac{2}{3} x - \frac{1}{9} \quad (7)$$

```
expr := rhs(sol);
```

$$-\frac{3}{2} x^2 + \frac{1}{9} e^{3x} + \frac{2}{3} x - \frac{1}{9} \quad (8)$$

```
evalf(eval(expr, x = 2), 6);
```

$$40.0476 \quad (9)$$

```
#Problem 2
restart :
with(LinearAlgebra) :

A := Matrix([[-2, 0, 0], [0, -1, 1], [0, -1, -1]]);
```

$$\begin{bmatrix} -2 & 0 & 0 \\ 0 & -1 & 1 \\ 0 & -1 & -1 \end{bmatrix} \quad (10)$$

#a
Eigenvalues(*A*);

$$\begin{bmatrix} -2 \\ -1-\mathrm{I} \\ -1+\mathrm{I} \end{bmatrix} \tag{11}$$

#b
expr := *MatrixExponential*(*t*·*A*);

$$\begin{bmatrix} e^{-2t} & 0 & 0 \\ 0 & e^{-t}\cos(t) & e^{-t}\sin(t) \\ 0 & -e^{-t}\sin(t) & e^{-t}\cos(t) \end{bmatrix} \tag{12}$$

#c
Map(*limit*, *MatrixExponential*(*t*·*A*), *t* = infinity);

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \tag{13}$$

Error, invalid input: VectorCalculus:-limit expects its 1st argument, f, to be of type {algebraic, Vector(algebraic)}, but received Matrix(3, 3, {(1, 1) = exp(-2*t), (1, 2) = 0, (1, 3) = 0, (2, 1) = 0, (2, 2) = exp(-t)*cos(t), (2, 3) = exp(-t)*sin(t), (3, 1) = 0, (3, 2) = -exp(-t)*sin(t), (3, 3) = exp(-t)*cos(t)})

#d
f := (*x*, *y*, *z*) → -2·*x* :
g := (*x*, *y*, *z*) → -*y* + *z* :
h := (*x*, *y*, *z*) → -*y* − *z* :

with(*linalg*) : *with*(*VectorCalculus*) :
Jm := *Jacobian*([*f*(*x*, *y*, *z*), *g*(*x*, *y*, *z*), *h*(*x*, *y*, *z*)], [*x*, *y*, *z*]);

$$\begin{bmatrix} -2 & 0 & 0 \\ 0 & -1 & 1 \\ 0 & -1 & -1 \end{bmatrix} \tag{14}$$

A := *subs*([*x* = 0, *y* = 0, *z* = 0], *Jm*);

$$\begin{bmatrix} -2 & 0 & 0 \\ 0 & -1 & 1 \\ 0 & -1 & -1 \end{bmatrix} \tag{15}$$

Eigenvalues(*A*);

$$\begin{bmatrix} -2 \\ -1-I \\ -1+I \end{bmatrix} \tag{16}$$

#*Problem 3*

restart :
#*a*
with(*linalg*) : *with*(*Student*[*LinearAlgebra*]) : *with*(*LinearAlgebra*) :
$f := x \rightarrow 3.4 \cdot x \cdot (1 - x)$;

$$x \rightarrow 3.4\, x\, (1 - x) \tag{17}$$

?*vector*
psi := [ ];

$$[\,] \tag{18}$$

$x := 0.4$;

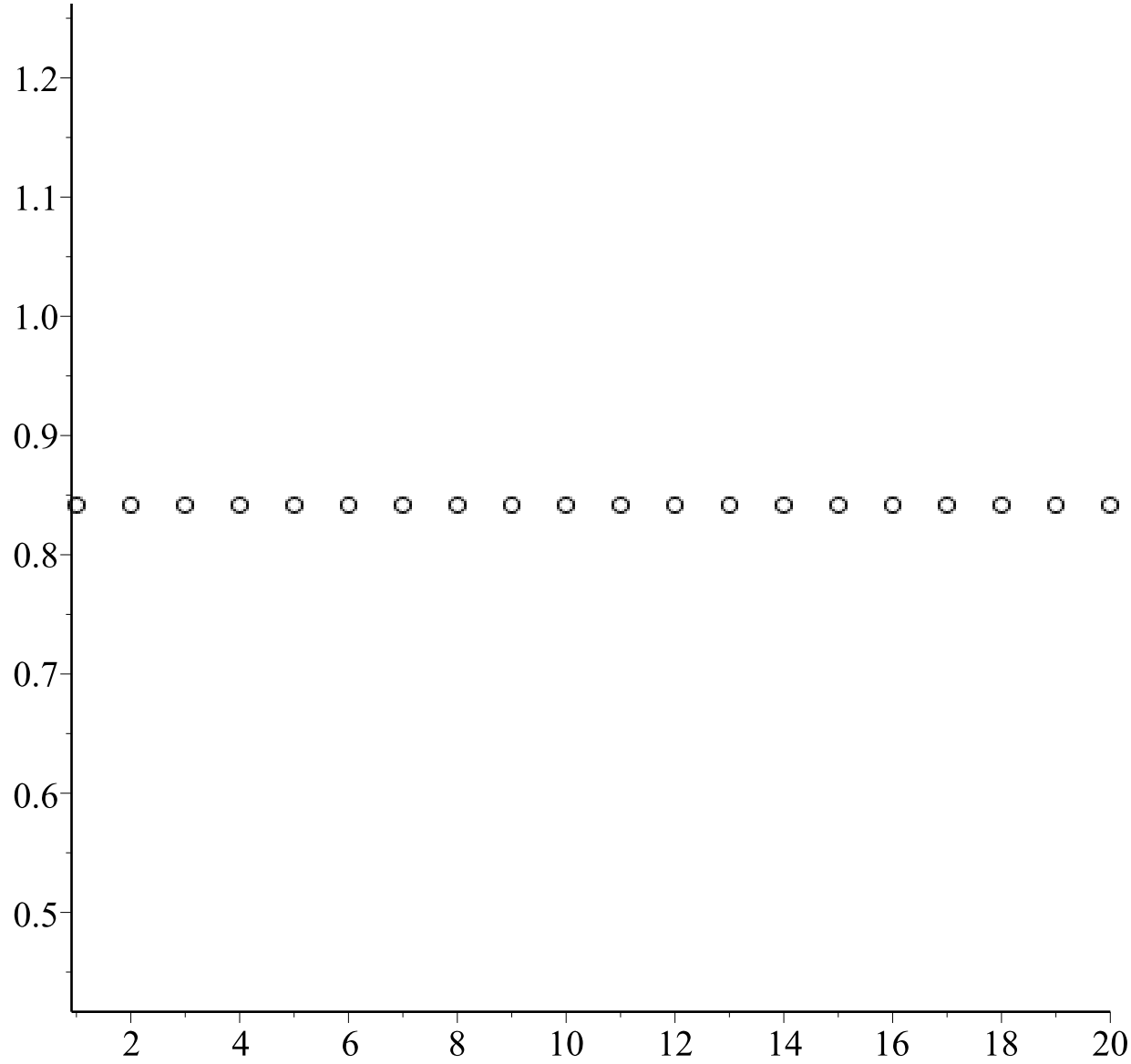
$$0.4 \tag{19}$$

for *i* **from** 1 **to** 20 **do** $x := f(x)$: psi(*i*) := x : *print*(psi(*i*)) :**od**:

0.5104896
0.8496258922
0.4343899006
0.8353640705
0.4676051968
0.8464319608
0.4419486483
0.8385421378
0.4603233513
0.8446475958
0.4461413181
0.8401374244
0.4566422106
0.8436083471
0.4485732329
0.8410079780
0.4546261004
0.8430001112
0.4499931406
0.8414976676 **(20)**

```
points := [[n, psi(n)]$n = 1..20]; with(plots) : pointplot(points, symbol = circle);
```

[[1, 0.8414976676], [2, 0.8414976676], [3, 0.8414976676], [4, 0.8414976676], [5, 0.8414976676], [6, 0.8414976676], [7, 0.8414976676], [8, 0.8414976676], [9, 0.8414976676], [10, 0.8414976676], [11, 0.8414976676], [12, 0.8414976676], [13, 0.8414976676], [14, 0.8414976676], [15, 0.8414976676], [16, 0.8414976676], [17, 0.8414976676], [18, 0.8414976676], [19, 0.8414976676], [20, 0.8414976676]]




```
#c
with(DETools) :
f := x→3.5·x·(1 − x);
```

$$x \to 3.5\,x\,(1 - x) \tag{21}$$

```
x := 0.4;
```

$$0.4 \tag{22}$$

```
for i from 1 to 20 do x := f(x) : psi(i) := x : print(psi(i)) :od:
```

0.840

0.4704000

0.8719334400

0.3908293067

0.8332861588

0.4862211773

0.8743355044

0.3845552555

0.8283537882

0.4976432643

0.8749805603

0.3828635279

0.8269766644

0.5008019132

0.8749977492

0.3828184083

0.8269396610

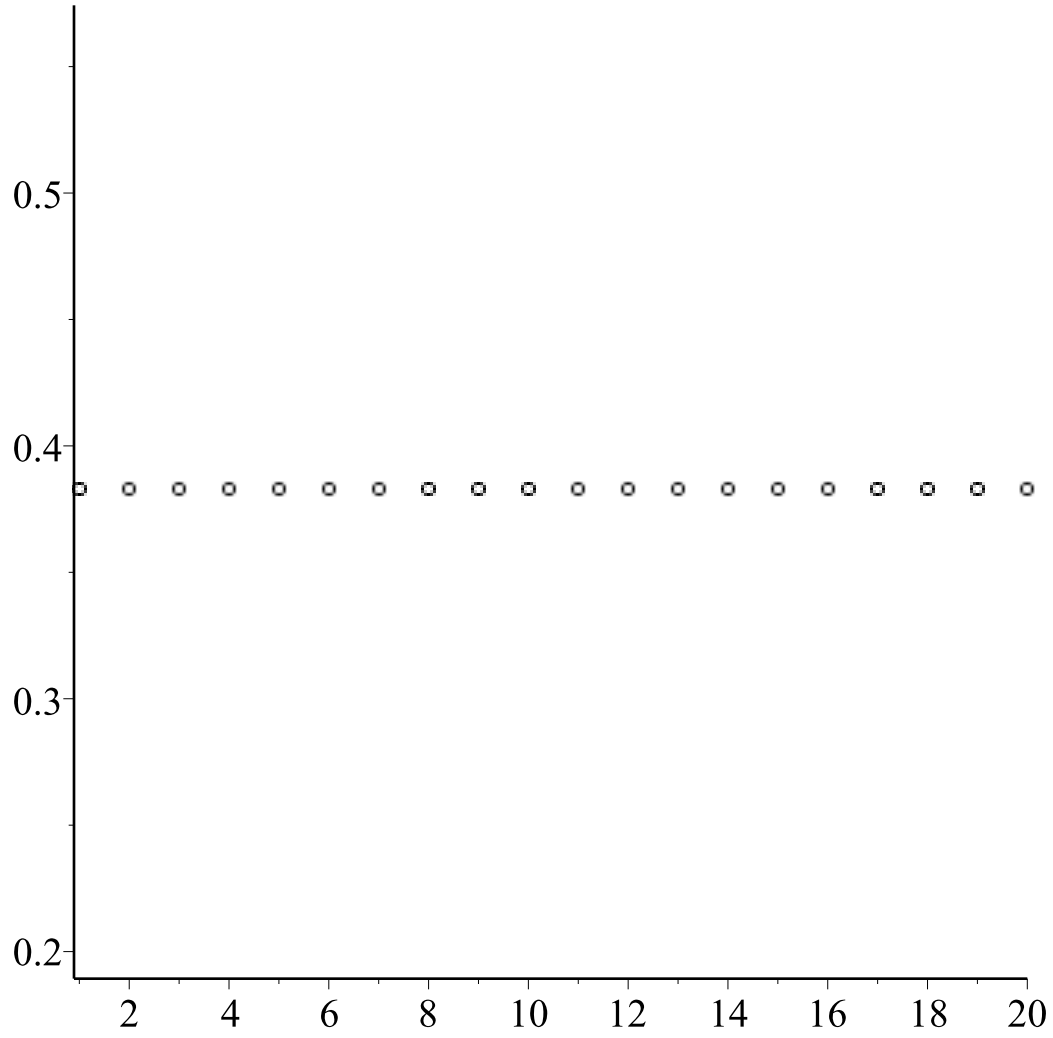
0.5008866033

0.8749972490

0.3828197214

(23)

$points := [[n, \mathrm{psi}(n)]\$n = 1..20] : with(plots) : pointplot(points, symbol = circle);$



#e

$x := 0.4;$

$$0.4 \quad \textbf{(24)}$$

$f := x \to 3.5 \cdot x \cdot (1 - x);$

$$x \to 3.5\, x\, (1 - x) \quad \textbf{(25)}$$

$\mathrm{psi}(1) := evalf(x, 7);$

$$0.4 \quad \textbf{(26)}$$

$\mathrm{psi}(2) := evalf(f(x), 7);$

$$0.840 \quad \textbf{(27)}$$

$\mathrm{psi}(3) := evalf(f(f(x)), 6);$

$$0.470400 \quad \textbf{(28)}$$

$\mathrm{psi}(4) := evalf(f(f(f(x))), 6);$

$$0.871933 \quad \textbf{(29)}$$

$\mathrm{psi}(5) := evalf(f(f(f(f(x)))), 6);$

$$0.390831 \quad \textbf{(30)}$$

```
psi(6) := evalf(f(f(f(f(f(x))))), 6);
```

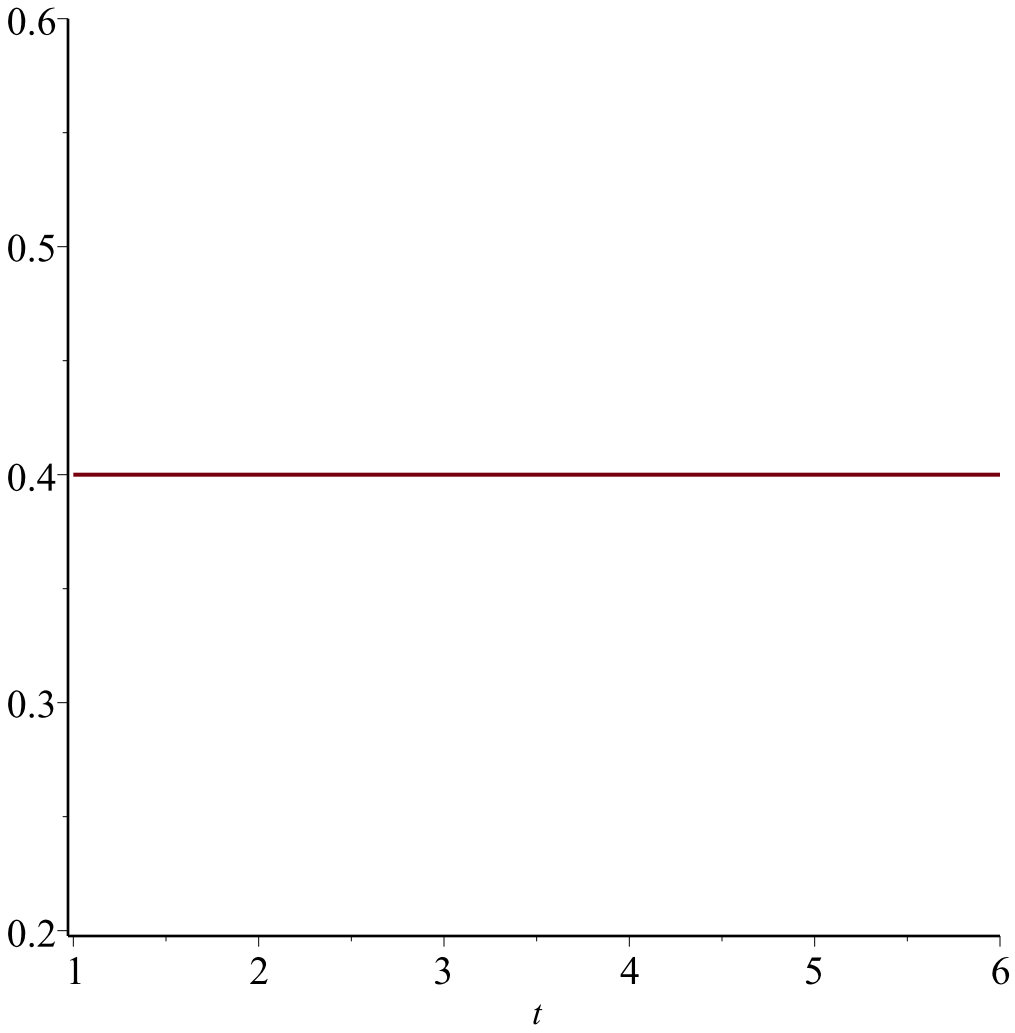
0.833288 **(31)**

```
psi(1); psi(2); psi(3);
```

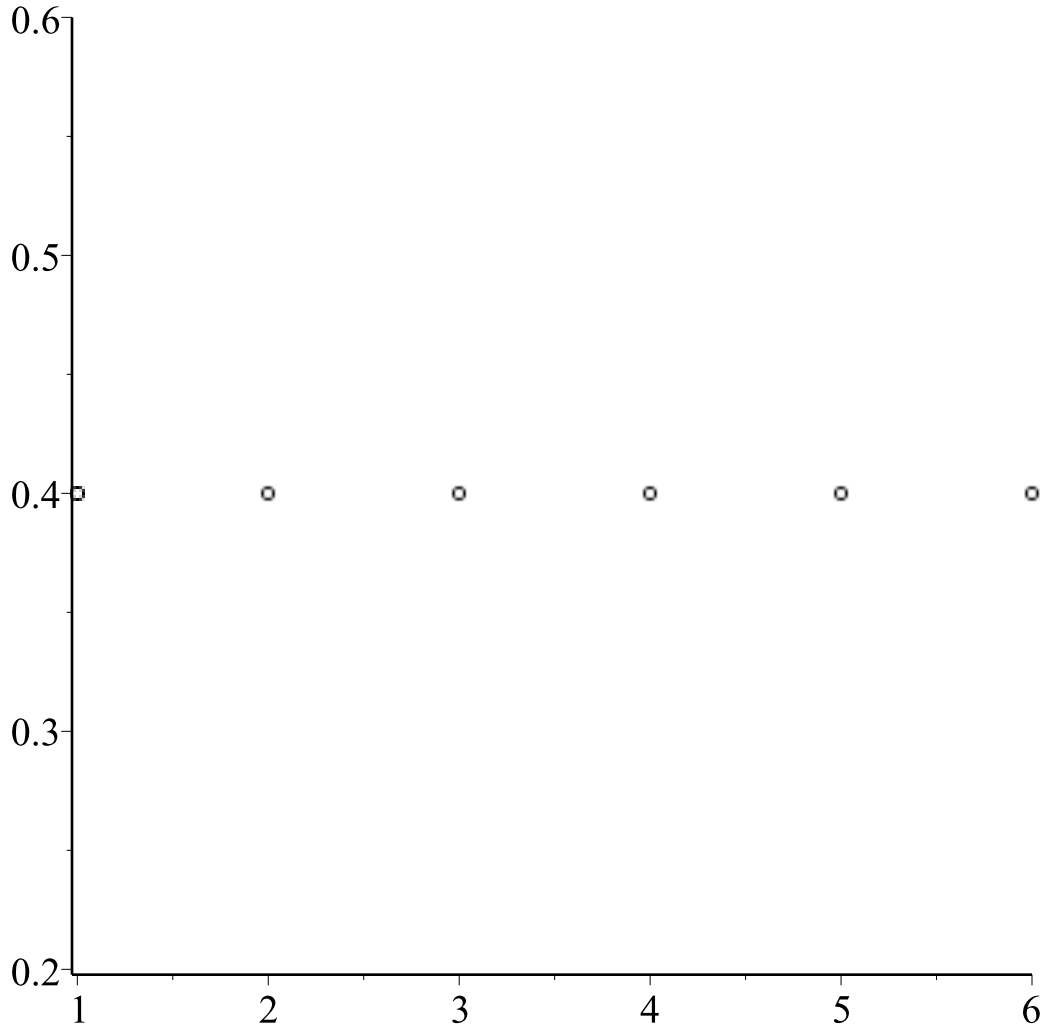
0.4

0.840

0.470400 **(32)**




```
points := [[n, psi(n)]$n = 1..6] : pointplot(points, symbol = circle);
```



#Problem 4
restart :
#a

$a := \mathrm{sqrt}(2);$

$$\sqrt{2} \quad (33)$$

$evalf(a^2 - 2);$

$$0. \quad (34)$$

#b

$b := evalf(\mathrm{sqrt}(2), 20);$

$$1.4142135623730950488 \quad (35)$$

$evalf(b^2 - 2);$

$$-1.\ 10^{-9} \quad (36)$$

#c
restart :
$E1 := \sin^2(x) + \cos^2(x);$

$$\sin(x)^2 + \cos(x)^2 \tag{37}$$

```
E2 := 1;
```

$$1 \tag{38}$$

```
x0 := Pi/7;
```

$$\frac{1}{7}\,\pi \tag{39}$$

```
evalf(eval(E1, x = x0));
```

$$0.9999999999 \tag{40}$$

```
evalf(eval(E2, x = x0));
```

$$1. \tag{41}$$

```
?evalf
```