Topic 6-Solving Differential Equations Usign Sympy

In [1]:
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#1) solve the differential equation dy/dx = 1
from sympy import*
x=Symbol("x")#defining independant
y=Function("y")(x)#defining Dependant
D=Eq(y.diff(x),1)#assignign differential equation
print(D)
display(D)
dsolve(D,y)
```

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Eq(Derivative(y(x), x), 1)
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$$\frac{d}{dx}y(x) = 1$$

Out[1]: $$y(x) = C_1 + x$$

In [9]:
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#2)Solve: dp/dt - r = 0
from sympy import*
t=Symbol("t")#defining independant
p=Function("p")(t)#defining Dependant
r=Symbol("r")
D=Eq(p.diff(t,1)-r, 0)#assignign differential equation
print(D)
display(D)
dsolve(D,p)
```

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Eq(-r + Derivative(p(t), t), 0)
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$$-r + \frac{d}{dt}p(t) = 0$$

Out[9]: $$p(t) = C_1 + rt$$

In [2]:
```
#3)Solve: 6y + 5dy/dx + d^2 y/dx^2 = 0
from sympy import*
x=Symbol("x")#defining independant
y=Function("y")(x)#defining Dependant
D=Eq(y.diff(x,2)+5*y.diff(x)+6*y,0)#assigning differential equation
print(D)
display(D)
dsolve(D,y)
```

```
Eq(6*y(x) + 5*Derivative(y(x), x) + Derivative(y(x), (x, 2)), 0)
```

$$6y(x) + 5\frac{d}{dx}y(x) + \frac{d^2}{dx^2}y(x) = 0$$

Out[2]: $$y(x) = \left(C_1 + C_2e^{-x}\right)e^{-2x}$$

In [4]:
```
#4)Solve: d^3 y/dx^3 + y = 0
from sympy import*
x=Symbol("x")#defining independant
y=Function("y")(x)#defining Dependant
D=Eq(y.diff(x,3)+y,0)#assigning differential equation
print(D)
```

```
display(D)
dsolve(D,y)
```

```
Eq(y(x) + Derivative(y(x), (x, 3)), 0)
```

$$y(x) + \frac{d^3}{dx^3}y(x) = 0$$

Out[4]:

$$y(x) = C_3 e^{-x} + \left(C_1 \sin\left(\frac{\sqrt{3}x}{2}\right) + C_2 \cos\left(\frac{\sqrt{3}x}{2}\right)\right) e^{\frac{x}{2}}$$

In [5]:

```
#5)Solve: d^3 y/dx^3 + y = 0; y(2) = 2, y(0) = 1, y(-1) = 0
from sympy import*
x=Symbol("x")#defining independant
y=Function("y")(x)#defining Dependant
D=Eq(y.diff(x,3)+y,0)#assigning differential equation
print("Differential equation:")
display(D)
Gs1=dsolve(D,y)
print("General solution:")
display(Gs1)
print("Particular solutions:")
S1=Gs1.subs({y:2,x:2})
display(S1)
S2=Gs1.subs({y:1,x:0})
display(S2)
S3=Gs1.subs({y:0,x:-1})
display(S3)
```

```
Differential equation:
```

$$y(x) + \frac{d^3}{dx^3}y(x) = 0$$

```
General solution:
```

$$y(x) = C_3 e^{-x} + \left(C_1 \sin\left(\frac{\sqrt{3}x}{2}\right) + C_2 \cos\left(\frac{\sqrt{3}x}{2}\right)\right) e^{\frac{x}{2}}$$

```
Particular solutions:
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$$2 = \frac{C_3}{e^2} + e\left(C_1 \sin\left(\sqrt{3}\right) + C_2 \cos\left(\sqrt{3}\right)\right)$$

$$1 = C_2 + C_3$$

$$0 = eC_3 + \frac{-C_1 \sin\left(\frac{\sqrt{3}}{2}\right) + C_2 \cos\left(\frac{\sqrt{3}}{2}\right)}{e^{\frac{1}{2}}}$$

In [15]:

```
#6) Find the general solution for the given DE: dp/dt - sin(t) - cos(t) and further
#   substitute t = 1 in general solution.

from sympy import *
t=Symbol('t')
r=Symbol('r')
p=Function('p')(t)
print("Differential equation")
DEL=Eq(p.diff(t,1)-(sin(t)+cos(t)),0)
display(DEL)
print("General solution")
GS1=dsolve(DEL,p)
display(GS1)
```

```
ps1=GS1.subs({t:1})
display(ps1)
```

Differential equation

$$-\sin(t) - \cos(t) + \frac{d}{dt}p(t) = 0$$

General solution

$$p(t) = C_1 + \sin(t) - \cos(t)$$

$$p(1) = C_1 - \cos(1) + \sin(1)$$

In [18]:

```
#7) Solve : df/dx = 5f; f(2) = 10.

from sympy import *
x=Symbol("x")
f=Function("f")(x)
print("Differential equation")
diff1=Eq(f.diff(x),5*f)
display(diff1)
print("General Solution")
Gs1=dsolve(diff1)
display(Gs1)
ps1=Gs1.subs({x:2,f:10})
C1=Symbol("C1")
print("Particular solution is ")
Gs1.subs({C1:(10/exp(10))})
```

Differential equation

$$\frac{d}{dx}f(x) = 5f(x)$$

General Solution

$$f(x) = C_1 e^{5x}$$

Particular solution is

Out[18]:

$$f(x) = \frac{10e^{5x}}{e^{10}}$$

In [ ]: