Computational Physics 2

PHY 459

Homework - 10

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1. Series Expansion:

Series expansion of the function $f(x) = e^{\left(-x^4+x^3-x^2\right)}$ around $x = 0$

```
In[ ]:= Series[Exp[-x^4 + x^3 - x^2], {x, 0, 5}]
```

$$\text{Out[ ]= } 1 - x^2 + x^3 - \frac{x^4}{2} - x^5 + 0[x]^6$$

2. Root Finding:

Find the root of the function $f(x) = x^4 + 3x^3 - 3x^2 + 10 = 0$

```
In[ ]:= Roots[(x^4 + 3 x^3 - 3 x^2 + 10) == 0, x]
```

$$\text{Out[ ]= } x == \frac{1}{2}\left(-5 - \sqrt{5}\right) \;||\; x == \frac{1}{2}\left(-5 + \sqrt{5}\right) \;||\; x == 1 - i \;||\; x == 1 + i$$

3. Finding Derivatives:

Third-order derivative of $x^3 ln\, x + cosh\, x$

```
In[ ]:= D[x^3 ln[x] + cosh[x], {x, 3}]
```

$$\text{Out[ ]= } 6\,\text{ln}[x] + 18\,x\,\text{ln}'[x] + 9\,x^2\,\text{ln}''[x] + \cosh^{(3)}[x] + x^3\,\text{ln}^{(3)}[x]$$

4. Numerical Integration:

Numerical integration of $\sqrt{1-x}$ in the region [0, 1]

In[2]:=
```
Integrate[Sqrt[1 - x], {x, 0, 1}]
```

Out[2]= $\frac{2}{3}$

5. Matrix Inversion:

Find the inverse of the matrix $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 8 \\ 3 & 2 & 1 \end{bmatrix}$

In[6]:=
```
MatrixForm[Inverse[{{1, 2, 3}, {4, 5, 8}, {3, 2, 1}}]]
```

Out[6]//MatrixForm=

$$\begin{pmatrix} -\frac{11}{8} & \frac{1}{2} & \frac{1}{8} \\ \frac{5}{2} & -1 & \frac{1}{2} \\ -\frac{7}{8} & \frac{1}{2} & -\frac{3}{8} \end{pmatrix}$$

6. Solving Differential Equations:

Numerically solve the differential equation $\frac{d^2 y}{d t^2} = -\frac{\pi^2 (y+1)}{4}$ with the boundary conditions $y(0) = 0$ and $y(1) = 1$

In[29]:=
```
fun = NDSolve[{y''[t] == -(Pi^2) (y[t] + 1) / 4, y[0] == 0, y[1] == 1}, y, {t, 0, 10}]
```

Out[29]= {{y → InterpolatingFunction[Domain: {{0., 10.}} Output: scalar]}}

In[30]:=
```
Plot[Evaluate[y[t] /. fun], {t, 0, 10}]
```

Out[30]=