Post_processing

April 30, 2023

1 Question (4)

1.1 A version of the Poisson equation that occurs in mechanics is the following model for the vertical deflection of a bar with a distributed load P (x):

$$A_c E \frac{d^2u}{dx^2} = P(x)$$

where A_c = cross-sectional area, E = Young's modulus, u = deflection, and x = distance measured along the bar's length. If the bar is rigidly fixed (u = 0) at both ends, use the finite-element method to model its deflections for Ac = 0.1m^2 , E = 200 × 109 N/m^2 , L = 10m, and P (x) = 100N/m. Employ a value of Δx = 0.5m.

2 Answer (4):

3 NOTE: Using the tolerance of 10^{-20} for jacobi solver

4 Import the necessary libraries

[1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

5 Reading the name of the files generated

[2]:
```
Output_files = pd.read_csv("Output_file_names.csv",delimiter=",",header=None).
  ↪to_numpy()
Output_files = np.squeeze(Output_files)
Output_files = Output_files.tolist()
```

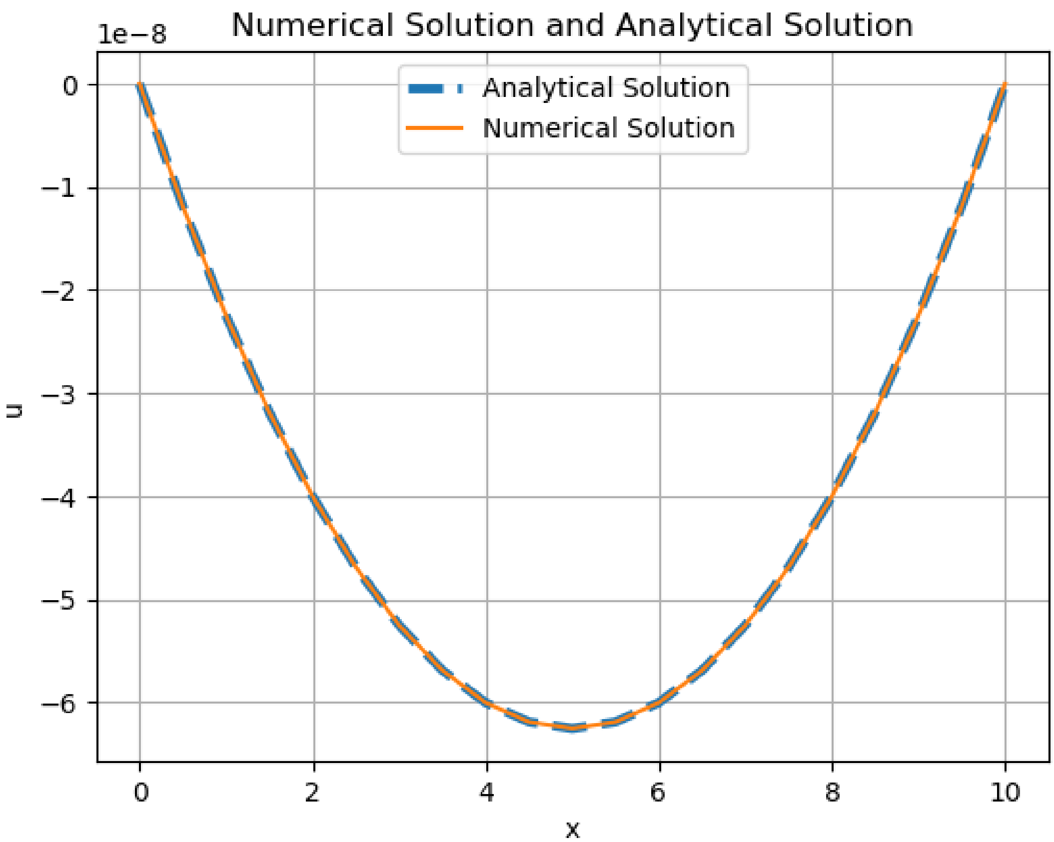
5.1 Output files generated

[3]:
```
Output_files
```

[3]:
```
['Question_4_u_Numerical_Solution.csv', 'Question_4_u_Analytical_Solution.csv']
```

5.2 Numerical solution for $\Delta x = 0.5m$

[4]:
```python
Numerical_Solution = pd.read_csv(Output_files[0],delimiter=",",header=None).
  ↪to_numpy()
Analytical_Solution = pd.read_csv(Output_files[1],delimiter=",",header=None).
  ↪to_numpy()
x = np.linspace(0, 10,Numerical_Solution.shape[0])
plt.plot(x,Analytical_Solution,linestyle='dashed',linewidth=3.5)
plt.plot(x,Numerical_Solution)
plt.xlabel("x")
plt.ylabel("u")
plt.legend(["Analytical Solution","Numerical Solution"])
plt.title("Numerical Solution and Analytical Solution")
plt.grid()
plt.savefig("Question_4.png",dpi = 500)
plt.show()
```



5.3 It is evident from the above graph that the numerical solution using FEM is in good agreement with the analytical solution.