ME 400/500 Homework, Fall 2013

Homework #12: Due Friday December 6

Consider the equation $y' = 1 + y^2$, $y(0) = 0$. Find a numerical solution in $0 \le x \le 1$ using:

a) Euler's method

b) Taylor's second order method

c) Runge-Kutta's fourth order method

d) Adams-Bashford's second order method

a) Use the analytical solution $y = \tan x$ to verify that the methods are converging at the expected rate. You should use at least three different time steps for this.

b) Compare the efficiency of the methods and report the results at x = 0.5 and x = 1.0 for each method to eight significant digits when the solution error is less than 0.00001.

ME 500 section only:

e) Adams Moulton second order method using *h* = 0.2

Homework #11: Due Wednesday November 20

ME 400:

Section 6.6, page 315. Problems 1, 4, 5

Section 7.2, page 350. Problems 17 c), d), e), f)

ME 500:

Section 6.6, page 315. Problems 1, 4, 5, 13

Section 7.2, page 350. Problems 17 c), d), e), f)

ME500 only

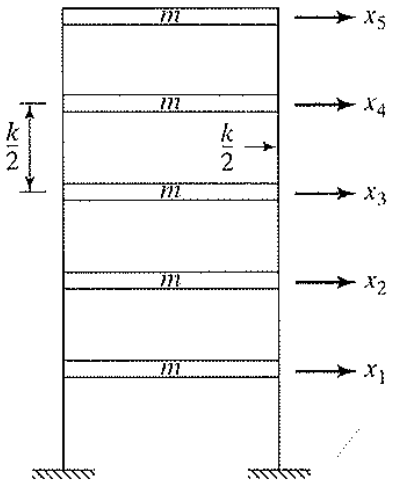
Use the Gauss Seidel method to solve the extra problem of HW#9. However, use a=0.005 which is the correct value. I mistakenly gave you the value of q which is 0.1 before.

Extra problem for both ME 400 and ME 500

1. The equations of motion of the 5-story building frame in the figure are

$$10^3\begin{bmatrix}1&0&0&0&0\\0&1&0&0&0\\0&0&1&0&0\\0&0&0&1&0\\0&0&0&0&1\end{bmatrix}\begin{bmatrix}\ddot{x}_1\\\ddot{x}_2\\\ddot{x}_3\\\ddot{x}_4\\\ddot{x}_5\end{bmatrix}+10^6\begin{bmatrix}2&-1&0&0&0\\-1&2&-1&0&0\\0&-1&2&-1&0\\0&0&-1&2&-1\\0&0&0&-1&1\end{bmatrix}\begin{bmatrix}x_1\\x_2\\x_3\\x_4\\x_5\end{bmatrix}=\begin{bmatrix}0\\0\\0\\0\\0\end{bmatrix}$$

assuming a solution of the form $x_i(t)=A_i\cos(\omega t+\phi)$, $i=1,2,...,5$ > Use the power method to find the largest and smallest natural frequencies and mode shapes of vibration of the building



k = 1.0 MN/m , *m* = 1000 kg

Start with $\mathbf{x}^0=\mathbf{1}$ and calculate λ_1 and λ_5 to at least five significant digits exactly. Show the last 5 iterations which lead to the values of the eigenvalue λ_5 .

Homework #10: Due Wednesday November 20

ME 400:

Section 6.3, page 281. Problems 2, 5

Section 6.4, page 292. Problems 8, 10, 12

Section 6.5, page 302. Problems 3, 5

ME 500:

Section 6.3, page 281. Problems 2, 5

Section 6.4, page 292. Problems 6, 10, 12

Section 6.5, page 302. Problems 3, 5

Extra problem:

The finite element discretization of the convection-diffusion equation

$$-k\frac{d^2\phi}{dx^2}+u\frac{d\phi}{dx}=q \quad , \quad \phi(0)=1 \quad , \quad \phi(1)=0$$

Leads to the solution of the linear system of equations

$$\begin{bmatrix} 2 & -1+\gamma & 0 & 0 & . & . & 0 & 0 & 0 & 0 \\ -1-\gamma & 2 & -1+\gamma & 0 & . & . & 0 & 0 & 0 & 0 \\ 0 & -1-\gamma & 2 & -1+\gamma & . & . & 0 & 0 & 0 & 0 \\ . & & & & & & & & & . \\ . & & & & & & & & & . \\ 0 & 0 & 0 & 0 & . & . & 0 & -1-\gamma & 2 & -1+\gamma \\ 0 & 0 & 0 & 0 & . & . & 0 & 0 & -1-\gamma & 2 \end{bmatrix} \begin{bmatrix} \phi_1 \\ \phi_2 \\ \phi_3 \\ . \\ . \\ \phi_{n-1} \\ \phi_n \end{bmatrix} = \begin{bmatrix} \gamma+1+a \\ a \\ a \\ . \\ . \\ a \\ a \end{bmatrix}$$

where $\phi_i=\phi(ih)$, $i=1,2,...,n$, h is the uniform element size, $\gamma=uh/k,$ and $a=qh$.

When the number of elements is 20, n = 19 and h = 0.05, set a = 0.1 solve the system for values of γ of 0.0, 1.0 and 10.0 using any direct solver based on Gauss elimination. Plot your results and discuss them.

Homework #9: Due Wednesday October 31

ME 400:

Section 5.3, page 229. Problem 2 (Apply to problem 2 a) of section 5.1 only. Find I_1 , I_2 , I_3 , I_4 and I_5. Compare with both the Trapezoidal and Simpson rules.)

Section 5.4, page 241. Problems 1 b), 10 b)

ME 500:

Section 5.3, page 229. Problem 2 (Apply to problem 2 a) of section 5.1 only. Find I_1 , I_2 , I_3 , I_4 and I_5. Compare with both the Trapezoidal and Simpson rules), 10

Section 5.4, page 241. Problems 1 b), 10 b), 14

Homework #8: Due Wednesday October 23

ME 400:

Section 5.1, page 200. Problems 4 a) and c) only, 12

Section 5.2, page 215. Problems 1 b) only, 7 a) only, 17 c) only

ME 500:

Section 5.1, page 200. Problems 4 a) and c) only, 12, 15

Section 5.2, page 215. Problems 7, 18 c) only, 20

Homework #7: Due Wednesday October 16.

ME 400:

Section 4.3, page 156. Problems 3 parts a), b), c) only

Section 4.4, page 164. Problem 2

Section 4.5, page 169. Problem 1

Section 4.6, page 177. Problem 4

Section 4.7, page 186. Problem 2

ME 500:

Section 4.3, page 156. Problems 3 parts a), b), c) only, 7

Section 4.4, page 164. Problem 2

Section 4.5, page 169. Problem 1

Section 4.6, page 177. Problem 2, 4

Section 4.7, page 186. Problem 2

Homework # 6: Due Wednesday October 9

ME 400:

Section 4.1, page 132. Problems 8a, 12, 17, 30

Section 4.2, page 1144. Problems 1, 7, 16

ME 500:

Section 4.1, page 132. Problems 8a, 12, 17, 21, 30

Section 4.2, page 1144. Problems 1, , 3, 7, 16

Homework # 5: Due Wednesday October 2

ME 400:

Section 3.4, page 106. Problems 3, 8, 11, 14

Section 3.5, page 116. Problems 1, 8

ME 500:

Section 3.4, page 106. Problems 1, 7, 11, 14, 18

Section 3.5, page 116. Problems 1, 6, 8

Homework # 4: Due Wednesday September 18

ME 400:

Section 3.1, page 77. Problems 2, 6, 10

Section 3.2, page 88. Problems 3, 5, 12b

Section 3.3, page 96. Problem 1, parts d) and g) only

ME 500:

Section 3.1, page 77. Problems 6, 10, 15

Section 3.2, page 88. Problems 3, 6, 13

Section 3.3, page 96. Problem 1, parts d) and g) only

Homework # 3: Due Wednesday September 11

ME 400:

Section 2.2, page 54. Problems 7, 9, 15

Section 2.3, page 62. Problems 4,10

Section 2.4, page 70. Problem 2

ME 500:

Section 2.2, page 54. Problems 5e, 13, 15

Section 2.3, page 62. Problems 2, 4,10

Section 2.4, page 70. Problem 2

Homework # 2: Due Wednesday September 4

ME 400:

Section 1.3, page 30. Problems 1, 9, 10

Section 2.1, page 41. Problems 1a, 1e

ME 500:

Section 1.3, page 30. Problems 1, 5, 9, 10

Section 2.1, page 41. Problems 1e, 7

Homework # 1: Due Wednesday August 28

ME 400:

Section 1.1, page 9. Problems 2a, 5, 8, 13

Section 1.2, page 18. Problems 4, 7, 9c, 12, 14, 17

ME 500:

Section 1.1, page 9. Problems 2a, 5, 8, 12, 13

Section 1.2, page 18. Problems 4, 7, 9c, 12, 14, 17, 22