Numerical Methods for Engineers [MAT2001 - 136]

Marks: 50 **Duration: 90 mins.**

MAT2001MEC

Answer all the questions.

1) The analysis of the voltage around the three loops gives the following equations for the currents in different parts of the an electrical circuit (Figure 1): (12)

$20(i_1 - i_2) + 10(i_1 - i_3) = 0$;

$25i_2 + 10(i_2 - i_3) + 20(i_2 - i_1) = 0$ and

$30i_3 + 10(i_3 - i_2) + 10(i_3 - i_1) = 200$

Find the currents by Gauss Siedal iterative scheme.

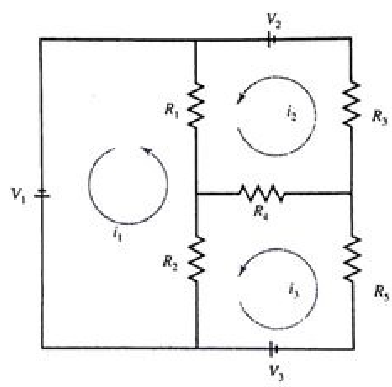

Figure 1

2) (a) When trying to find the acidity of a solution of magnesium hydroxide in hydrochloric acid, we obtain the following eqution (14)

$$f(x) = e^{-0.5x}(4 - x) - 2$$

where x is the hydronium ion concentration. Find the hydronium ion concentration for a saturated solution (acidity equal to zero) using a suitable iterative scheme. (7M)

(b) Find the solution for the steady state of the concentration, of two chemical species, in an oscillatroy chemical system described by the nonlinear system:

$x^2 - \sqrt{3}xy + 2y^2 - 10 = 0$; $4x^2 + 3\sqrt{3}xy + y^2 - 22 = 0$; (7M)

3) For a three mass-four spring system, between two fixed walls, the displacements for the masses can be expresses as the following homogeneous set of equations: (12)

$\left(\frac{2k}{m_1} - \omega^2\right)x_1 - \frac{k}{m_1}x_2 = 0$; $-\frac{k}{m_2}x_1 + \left(\frac{2k}{m_2} - \omega^2\right)x_2 - \frac{k}{m_2}x_3 = 0$ and

$-\frac{k}{m_3}x_2 + \left(\frac{2k}{m_3} - \omega^2\right)x_3 = 0$

If all the masses m_i= 1kg and all the spring constants k =20 N/m, express the system in the matrix format as $[A] - \lambda[I] = 0$ where λ is the square of the angular frequency ω^2. Employ the power method to determine the highest eigen value and its associated eigen vector. Explain how the smallest eigen value can be obtained by power method.

4) Using LU Decomposition method, solve $\begin{bmatrix} 1 & 1 & 1 \\ 4 & 3 & -1 \\ 3 & 5 & 3 \end{bmatrix}\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 3 \\ 6 \\ 11 \end{bmatrix}$ (12)

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