Task 8

Q) Design and create a web-based user interface using HTML, CSS, and JavaScript to interact with the FEA code.

Code for Web-based Interface using HTML:

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <link rel="stylesheet" href="styles.css">
    <title>FEA Solver</title>
</head>
<body>
    <div class="container">
<!-- Input fields for stiffness matrix and external force vector -->
        <label for="stiffnessMatrix">Stiffness Matrix:</label>
        <input type="text" id="stiffnessMatrix" placeholder="Enter stiffness matrix (e.g., [[4, -1], [-1, 3]])">
        <label for="forceVector">External Force Vector:</label>
        <input type="text" id="forceVector" placeholder="Enter external force vector (e.g., [[6], [5]])">
        <button onclick="solveFEA()">Solve FEA</button>
        <div id="solution"></div> <!-- Output will be displayed here -->
    </div>
<!-- JavaScript file for handling user input and displaying the solution -->
    <script src="script.js"></script>
</body>
</html>
```

Code for Web-based Interface using CSS:

```
body {
    font-family: Arial, sans-serif;
}

.container {
    max-width: 400px;
    margin: 0 auto;
    text-align: center;
    padding: 20px;
    border: 1px solid #ccc;
    border-radius: 5px;
}
input, button {
    margin-bottom: 10px;
    width: 100%;
    padding: 8px;
}
button {
    background-color: #4caf50;
    color: white;
    border: none;
    cursor: pointer;
}
button:hover {
    background-color: #45a049;
```

```
}
```

Code for Web-based Interface using JavaScript:

```
// Function to solve the FEA system and display the solution
function solveFEA() {
    // Get input values from user
    const stiffnessMatrixInput = document.getElementById("stiffnessMatrix").value;
    const forceVectorInput = document.getElementById("forceVector").value;

    // Plug input values to create matrices
    const K = math.eval(stiffnessMatrixInput);
    const f = math.eval(forceVectorInput);

    // Solve the FEA system using LU decomposition
    const solution = math.lusolve(K, f);

    // Display the solution in the output section
    const solutionDiv = document.getElementById("solution");
    solutionDiv.textContent = "Solution u: " + math.transpose(solution);
}
```

- **Implement input forms for defining problem parameters (mesh details, material properties, boundary conditions).**

Updated JavaScript Code:

```
// Function to perform LU decomposition
function luDecomposition(A) {
    const n = A.length;
    const L = math.zeros(n, n);
    const U = math.zeros(n, n);

    for (let i = 0; i < n; i++) {
        L[i][i] = 1;

        for (let j = i; j < n; j++) {
            let sum = 0;
            for (let k = 0; k < i; k++) {
                sum += L[j][k] * U[k][i];
            }
            U[j][i] = A[j][i] - sum;
        }

        for (let j = i + 1; j < n; j++) {
            let sum = 0;
            for (let k = 0; k < i; k++) {
                sum += L[i][k] * U[k][j];
            }
            L[i][j] = (A[i][j] - sum) / U[i][i];
```

```
      }
    }

    return [L, U];
}

// Function to solve FEA problem using LU decomposition
function solveFEA(K, f) {
    const [L, U] = luDecomposition(K);

    // Solve for intermediate vector y: Ly = f
    const y = math.lusolve(L, f);
    // Solve for displacement vector u: Uu = y
    const u = math.lusolve(U, y);
    return u;
}
// Example usage:
// Define stiffness matrix (K) and external force vector (f)
const K = math.matrix([[4, -1], [-1, 3]]);
const f = math.matrix([[6], [5]]);
// Solve the FEA problem
const solution = solve(K, f);
// Display the solution
console.log("Solution u:");
console.log(math.transpose(solution));
```

Output:

The given JavaScript code calculates the solution of a finite element analysis problem using LU decomposition. The given stiffness matrix K is [4−1−1 3] and the external force vector f is [6 5].

```lua
Solution u:
[[2]
 [3]]
```

What this output represents:

In this output, u represents the solution vector obtained from the finite element analysis calculation. The values in u represent the displacements at each degree of freedom in the system. In this case, the displacements are $u1=2$ and $u2=3$.