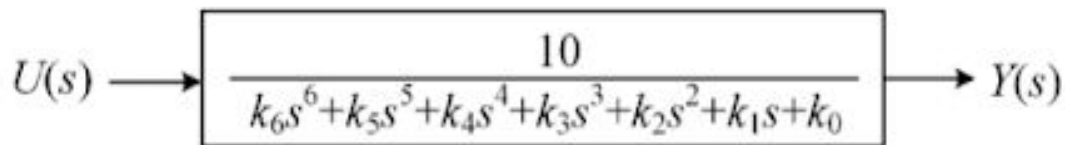


EE-302 Control System

(Routh Table and pole location results)

Group 8: Create a GUI based system that plots the Routh table for the system shown below. Comment on the number of poles in the right-half plane, the left-half plane, and on the imaginary axis. The parameter values $k_0, k_1, k_2, k_3, k_4, k_5, k_6$ will be provided from user-end.



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Example:1

Input:- $s^6 + 2s^5 + 3s^4 + 4s^3 + 5s^2 + 6s + 2$

Output:-

The screenshot shows a software window titled 'ee302' with three main sections: 'Input System Equation', 'Routh table', and 'Results'.

Input System Equation: A polynomial is entered as $s^6 + 2s^5 + 3s^4 + 4s^3 + 5s^2 + 6s + 2$. Below the input is an 'Evaluate' button.

Routh table: A table with 7 rows (s6 to s0) and 4 columns of coefficients.

	1	3	5	2
s6	1	3	5	2
s5	2	4	6	0
s4	1	2	2	0
s3	0.01	2	0	0
s2	-198	2	0	0
s1	2.0001	0	0	0
s0	2	0	0	0

Results: The stability status is 'Unstable'. The number of poles is: In right-half plane: 2, In left-half plane: 4, On imaginary axis: 0. The roots are: $0.58263+1.1947i$, $0.58263-1.1947i$, $-0.68917+1.1705i$, $-0.68917-1.1705i$, -1.3233 , and -0.46365 .

This system is unstable.

Example:2

Input:- $3*s^6 + 2*s^5 + 7*s^4 + 4*s^3 + 3*s^2 + 2$

Output:-

The screenshot shows a software window titled 'ee302' with the following components:

- Input System Equation:** A text input field containing the equation $3s^6 + 2s^5 + 7s^4 + 4s^3 + 3s^2 + 2$. Below it is an 'Evaluate' button.
- Results:** A section containing:
 - Stability status:** A dropdown menu showing 'Unstable'.
 - Number of poles:** Three input fields showing the count of poles in different regions:
 - In right-half plane: 2
 - In left-half plane: 4
 - On imaginary axis: 0
 - Roots:** A grid of six input fields showing the complex roots of the equation:
 - 2.7756e-16+1.4142i
 - 2.7756e-16-1.4142i
 - 0.66725+0.60903i
 - 0.66725-0.60903i
 - 0.33392+0.54491i
 - 0.33392-0.54491i
- Routh table:** A table showing the Routh array for the given equation.

	s^6	s^5	s^4	s^3	s^2	s^1	s^0
Row 1	3	7	3	2			
Row 2	2	4	0	0			
Row 3	1	3	2	0			
Row 4	-2	-4	0	0			
Row 5	1	2	0	0			
Row 6	2	0	0	0			
Row 7	2	0	0	0			

This system is unstable.

Example:3

Input:- $s^6 + (3.25)s^5 + (6.6)s^4 + (8.6)s^3 + (7.45)s^2 + (3.95)s + 1$

Output:-

The screenshot shows a software interface for system stability analysis. The window is titled "ee302". It contains three main sections:

- Input System Equation:** A text area showing the polynomial $s^6 + 3.25s^5 + 6.6s^4 + 8.6s^3 + 7.45s^2 + 3.95s + 1$. Below it is an "Evaluate" button.
- Routh table:** A table showing the Routh array for the polynomial. The rows are labeled S6, S5, S4, S3, S2, S1, and S0. The columns contain the coefficients and the results of the Routh calculations.
- Results:** A section showing the stability status, the number of poles in different regions, and the roots of the polynomial.

Input System Equation

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1 S^6+ 3.25 S^5+ 6.6 S^4+ 8.6 S^3+ 7.45 S^2+ 3.95 S^1+ 1

Evaluate

Results

Stability status: Stable

Number of poles

In right-half plane: 0

In left-half plane: 6

On imaginary axis: 0

Roots

-0.30986+1.2634i -0.30986-1.2634i -0.58051+0.78283i

-0.58051-0.78283i -0.73463+0.28725i -0.73463-0.28725i

Routh table

	S6	S5	S4	S3	S2	S1	S0
1	1	3.25	6.6	8.6	7.45	3.95	1
2	3.95	6.2346	1	0	0	0	0
3	3.4752	3.128	0	0	0	0	0
4	2.6758	1	0	0	0	0	0
5	1.8293	0	0	0	0	0	0
6	1	0	0	0	0	0	0

This system is stable.

Example:4

Input:- $s^4 + 3s^3 + 3s^2 + 2s + 1$

Output:-

The screenshot shows a software window titled 'ee302' with a light gray background. It contains two main panels: 'Input System Equation' and 'Results'.

Input System Equation: This panel has a title bar with a small icon and the text 'ee302'. Below the title, there is a horizontal line with the number '20' centered above it. Below the line, there is a row of input fields containing the coefficients of the polynomial: 0, s^6+ , 0, s^5+ , 1, s^4+ , 3, s^3+ , 3, s^2+ , 2, s^1+ , 1. Below this row is a blue button labeled 'Evaluate'.

Results: This panel displays the results of the stability analysis. It includes a 'Stability status' section with a dropdown menu showing 'Stable'. Below this is a 'Number of poles' section with three sub-sections: 'In right-half plane' (0), 'In left-half plane' (4), and 'On imaginary axis' (0). Below these are 'Roots' displayed in three columns: -1.7549, -1, and -0.12256+0.74486i. Below the roots are two empty input fields.

Routh table: This panel displays the Routh table for the polynomial. It has a title bar with the text 'Routh table'. Below the title, there is a table with 7 rows and 4 columns. The rows are labeled S6, S5, S4, S3, S2, S1, and S0. The columns contain the coefficients of the polynomial and the results of the Routh-Hurwitz criterion.

	1	3	1	
S6				
S5				
S4	1	3	1	
S3	3	2	0	
S2	2.3333	1	0	
S1	0.71429	0	0	
S0	1	0	0	

This system is stable.

Example:5

Input:- $s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16$

Output:-

The screenshot shows a MATLAB/Simulink window titled 'ee302'. It contains a form for evaluating a system's stability. The 'Input System Equation' section shows the polynomial $s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16$ with coefficients entered in a row of boxes. Below this is an 'Evaluate' button. The 'Results' section shows the stability status as 'Stable', the number of poles in the right-half plane as 0, in the left-half plane as 6, and on the imaginary axis as 0. It also lists the roots: $-5.5511e-16+2i$, $-5.5511e-16-2i$, $-1+i$, $-1-i$, $3.4694e-16+1.4142i$, and $3.4694e-16-1.4142i$. The 'Routh table' section displays the following table:

	s^6	s^5	s^4	s^3	s^2	s^1	s^0
1	1	2	8	12	20	16	16
2	2	12	16	0	0	0	0
3	8	24	0	0	0	0	0
4	6	16	0	0	0	0	0
5	2.6667	0	0	0	0	0	0
6	16	0	0	0	0	0	0

This system is stable.

Example:6

Input:- $s^6 + 3s^5 + 3s^4 + 2s^3 + s^2$

Output:-

The screenshot shows a MATLAB/Simulink window titled 'ee302'. It contains a form for evaluating a system equation. The 'Input System Equation' section shows the polynomial $s^6 + 3s^5 + 3s^4 + 2s^3 + s^2$ with coefficients entered in boxes. An 'Evaluate' button is present. The 'Results' section shows the stability status as 'Marginally Stable'. It also displays the number of poles in the right-half plane (0), left-half plane (4), and on the imaginary axis (2). The roots are listed as 0, -1, and a pair of complex conjugates: $-0.12256 \pm 0.74486i$. The 'Routh table' section shows the following table:

	s^6	s^5	s^4	s^3	s^2
s^6	1	3	1	0	
s^5	3	2	0	0	
s^4	2.3333	1	0	0	
s^3	0.71429	0	0	0	
s^2	1	0	0	0	
s^1	2	0	0	0	
s^0	2	0	0	0	

This system is marginally stable.

Example:7

Input:- $s^6 + 5s^5 + 9s^4 + 8s^3 + 5s^2 + 2s$

Output:-

The screenshot shows a software window titled 'ee302' with a light gray background. It is divided into three main sections:

- Input System Equation:** A horizontal row of input fields containing the coefficients of the polynomial $s^6 + 5s^5 + 9s^4 + 8s^3 + 5s^2 + 2s$. The fields are labeled from left to right: '1', 'S^6+', '5', 'S^5+', '9', 'S^4+', '8', 'S^3+', '5', 'S^2+', '2', 'S^1+', and '0'. Below this row is a blue button labeled 'Evaluate'.
- Results:** This section contains the following information:
 - Stability status:** A dropdown menu showing 'Marginally Stable'.
 - Number of poles:** Three sub-sections: 'In right-half plane' with value '0', 'In left-half plane' with value '5', and 'On imaginary axis' with value '1'.
 - Roots:** A grid of six text boxes showing the roots: '0', '-2', '-1.7549', '-1', '-0.12256+0.74486i', and '-0.12256-0.74486i'.
- Routh table:** A table with 7 rows (S6 to S0) and 4 columns. The values are:

	S6	S5	S4	S3	S2	S1	S0
1	1	9	5	0			
5	5	8	2	0			
7.4	7.4	4.6	0	0			
4.8919	4.8919	2	0	0			
1.5746	1.5746	0	0	0			
2	2	0	0	0			
2	2	0	0	0			

This system is marginally stable.