**ML_13_2_1** to calculate the values in a Routh table

```
% Onwubolu, G. C.
% Mechatronics: Principles & Applications
% Elsevier
%
% Mechatronics: Principles & Applications Toolbox Version 1.0
% Copyright © 2005 by Elsevier
%
% Chapter 13: Stability via Routh table
%
% Example 13.6    MATLAB's Symbolic Math Toolbox may
% be used conveniently to calculate  the values in a Routh table.
% We now demonstrate the making of a Routh table using the Symbolic Math Toolbox
% or a problem that requires the epsilon method to complete the table. The following
% program produces the Routh table for Example 13.6 in the text. Also, for clarity,
% we convert all rows to symbolic objects, simplify, and pretty print after forming
% the table. Caution: In general, the results of this program are not valid if an
% entire row is zero as e approaches zero, such as [e 0 0 0]. This case must be
% handled differently, as discussed in the subsection,
% "Entire Row is Zero."

'Example 13.6'       % Display label.
% -det([si() si();sj() sj()])/sj()
                     % Template for use in each cell.
syms e                    % Construct a symbolic object for
                     % epsilon.
%%%%%%%%%%%%%%%%%%%%%%%%%%
s5=[1   5   6   0   0];       % Create s^5 row of Routh table.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
s4=[1   5   2   0   0];       % Create s^4 row of Routh table.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
if -det([s5(1) s5(2);s4(1) s4(2)])/s4(1)==0
        s3=[e...
 -det([s5(1) s5(3);s4(1) s4(3)])/s4(1)   0   0];
                     % Create s^3 row of Routh table
                     % if 1st element is 0.
else
   s3=[-det([s5(1) s5(2);s4(1) s4(2)])/s4(1)...
 -det([s5(1) s5(3);s4(1) s4(3)])/s4(1)   0   0];
                     % Create s^3 row of Routh table
                     % if 1st element is not zero.
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
if -det([s4(1) s4(2);s3(1) s3(2)])/s3(1)==0
        s2=[e ...
```

```
 -det([s4(1) s4(3);s3(1) s3(3)])/s3(1)   0   0];
                        % Create s^2 row of Routh table
                        % if 1st element is 0.
else
    s2=[-det([s4(1) s4(2);s3(1) s3(2)])/s3(1) ...
 -det([s4(1) s4(3);s3(1) s3(3)])/s3(1)   0   0];
                        % Create s^2 row of Routh table
                        % if 1st element is not zero.
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
if -det([s3(1) s3(2);s2(1) s2(2)])/s2(1)==0
          s1=[e ...
 -det([s3(1) s3(3);s2(1) s2(3)])/s2(1)   0   0];
                        % Create s^1 row of Routh table
                        % if 1st element is 0.
else
s1=[-det([s3(1) s3(2);s2(1) s2(2)])/s2(1) ...
 -det([s3(1) s3(3);s2(1) s2(3)])/s2(1)   0   0];
                        % Create s^1 row of Routh table
                        % if 1st element is not zero
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
s0=[-det([s2(1) s2(2);s1(1) s1(2)])/s1(1) ...
 -det([s2(1) s2(3);s1(1) s1(3)])/s1(1)   0   0];
                        % Create s^0 row of Routh table.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
's5'                    % Display label.
s5=sym(s5);                 % Convert s5 to a symbolic object.
s5=simplify(s5);            % Simplify terms in s^5 row.
pretty(s5)                % Pretty print s^5 row.
's4'                    % Display label.
s4=sym(s4);                 % Convert s4 to a symbolic object.
s4=simplify(s4);            % Simplify terms in s^4 row.
pretty(s4)                % Pretty print s^4 row.
's3'                    % Display label.
s3=sym(s3);                 % Convert s3 to a symbolic object.
s3=simplify(s3);            % Simplify terms in s^3 row.
pretty(s3)                % Pretty print s^3 row.
's2'                    % Display label.
s2=sym(s2);                 % Convert s2 to a symbolic object.
s2=simplify(s2);            % Simplify terms in s^2 row.
pretty(s2)                % Pretty print s^2 row.
's1'                    % Display label.
s1=sym(s1);                 % Convert s1 to a symbolic object.
s1=simplify(s1);            % Simplify terms in s^1 row.
pretty(s1)                % Pretty print s^1 row.
's0'                    % Display label.
s0=sym(s0);                 % Convert s0 to a symbolic object.
s0=simplify(s0);            % Simplify terms in s^0 row.
pretty(s0)                % Pretty print s^0 row.
```