ECE 202
M8
Hand Calculations.

$$R(x) = \frac{6 + 5x + 4x^2}{(x-1)(x-2)(x-3)} = \frac{C_1}{(x-1)} + \frac{C_2}{(x-2)} + \frac{C_3}{(x-3)}$$

$$= \frac{C_1(x-2)(x-3)}{(x-1)(x-2)(x-3)} + \frac{C_2(x-1)(x-3)}{(x-1)(x-2)(x-3)} + \frac{C_3(x-1)(x-2)}{(x-1)(x-2)(x-3)}$$

$$\Rightarrow \frac{6 + 5x + 4x^2}{(x-1)(x-2)(x-3)} = \frac{C_1(x-2)(x-3) + C_2(x-1)(x-3) + C_3(x-1)(x-2)}{(x-1)(x-2)(x-3)}$$

$$\Rightarrow 6 + 5x + 4x^2 = C_1x^2 - 5C_1x + 6C_1 + C_2x^2 - C_2x - 3C_2x + 3C_2 + C_3x^2 - C_3x - C_3x + 2C_3$$

$$\Rightarrow 6 + 5x + 4x^2 = x^2(C_1 + C_2 + C_3) + x(-5C_1 - 4C_2 - 3C_3) + (6C_1 + 3C_2 + 2C_3)$$

$$\Rightarrow \begin{aligned} C_1 + C_2 + C_3 &= 4 \\ -5C_1 - 4C_2 - 3C_3 &= 5 \\ 6C_1 + 3C_2 + 2C_3 &= 6 \end{aligned} \Rightarrow \begin{bmatrix} 1 & 1 & 1 \\ -5 & -4 & -3 \\ 6 & 3 & 2 \end{bmatrix} \begin{bmatrix} C_1 \\ C_2 \\ C_3 \end{bmatrix} = \begin{bmatrix} 4 \\ 5 \\ 6 \end{bmatrix}$$

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% Sounak Ghosh
% 11/28/19
% ECE 202 - Fall 2019 - MATLAB Exercise M8
% Solving a system of linear equations using the Inverse Method to convert
% to partial fraction expansion.

clear % clears all variables in the workpace; avoids common errors

xmin = -4;                          % min value of x
xmax = 4;                           % max value of x
n = input("Number of Terms = ");    % number of points to have in the array
x = linspace(xmin, xmax, n);        % making an array of n points from xmin to xmax

% ------ Given ---------
c = 6;                  % value of c in the eqn. ax^2+bx+c
b = 5;                  % value of b in the eqn, ax^2+bx+c
bx = b*x;               % bx in ax^2+bx+c
a = 4;                  % value of a in the eqn, ax^2+bx+c
ax2 = a * x.^2;         % ax^2 in ax^2+bx+c

% ------ Fraction Expansion ---------
N = ax2 + bx + c;       % Numerator i.e. 4x^2+5x+6
D1 = x - 1;            % Denominator for the first term
D2 = x - 2;            % Denominator for the second term
D3 = x - 3;            % Denominator of termthe third
D = D1 .* D2 .* D3;    % Common denominator

% ------ Matrix calculation ---------
A = [1 1 1; -5 -4 -3; 6 3 2];  % Coefficient matrix A of Ax=b
b = [4 ; 5; 6];        % b matrix of Ax=b
C = inv(A)* b          % find the solution of a system of linear eqn. through the inverse method

R_Lhs = N./D;           % left hand side eqn. R(x) = N(x)/D(x)
R1 = C(1)./D1;          % first RHS term
R2 = C(2)./D2;          % second RHS term
R3 = C(3)./D3;          % third RHS term
R_Rhs = R1 + R2 + R3;     % RHS total

% ------- Checks ---------------------
check = sum(abs(R_Lhs - R_Rhs))  % check using the absolute value function

% For some values of n like 5, 9 etc. it results in a zero in x array which
% is used to calculate the denominator of the array causing matlab to show
% Not A Number (NaN) as it can't divide by zero. The number of input terms
% i.e. the intervals in the linspace command can cause to have zero as one
% of the values in the array and we use the x array values to calculate the
% denominator, which with a zero will result in a NaN (not a number) as
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48 % no number can be divided by zero.
49
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>> M8
Number of Terms = 4

C =

    7.5000
  -32.0000
   28.5000


check =

   2.7367e-14

>> M8
Number of Terms = 5

C =

    7.5000
  -32.0000
   28.5000


check =

   NaN

>> M8
Number of Terms = 6

C =

    7.5000
  -32.0000
   28.5000


check =

   1.0628e-13

>> M8
Number of Terms = 7

C =
```

```
 47
 48     7.5000
 49   -32.0000
 50    28.5000
 51
 52
 53 check =
 54
 55    1.1546e-13
 56
 57 >> M8
 58 Number of Terms = 8
 59
 60 C =
 61
 62     7.5000
 63   -32.0000
 64    28.5000
 65
 66
 67 check =
 68
 69    3.0526e-13
 70
 71 >> M8
 72 Number of Terms = 9
 73
 74 C =
 75
 76     7.5000
 77   -32.0000
 78    28.5000
 79
 80
 81 check =
 82
 83    NaN
 84
 85 >> M8
 86 Number of Terms = 10
 87
 88 C =
 89
 90     7.5000
 91   -32.0000
 92    28.5000
```

```
 93
 94
 95 check =
 96
 97    3.1602e-13
 98
 99 >> M8
100 Number of Terms = 11
101
102 C =
103
104     7.5000
105   -32.0000
106    28.5000
107
108
109 check =
110
111    2.3695e-13
112
113 >> M8
114 Number of Terms = 12
115
116 C =
117
118     7.5000
119   -32.0000
120    28.5000
121
122
123 check =
124
125    3.4750e-13
126
127 >> M8
128 Number of Terms = 13
129
130 C =
131
132     7.5000
133   -32.0000
134    28.5000
135
136
137 check =
138
```

```
    NaN

>> M8
Number of Terms = 14

C =

     7.5000
   -32.0000
    28.5000


check =

    4.6982e-13

>>
```