```
% Clear the workspace and command window
clear;
clc;

% Define the symbolic variable x and pi
syms x;

% Define the function f(x)
f = x^2;

% Define the number of terms in the Fourier series (n)
n = 3;  % Change this value as desired

% limits of integration
L = -pi;
U = pi;
lb = sym(L); %lower bound/limit
ub = sym(U); %upper bound/limit


% Calculate the Fourier coefficients
a000 = (1/sym(pi)) * int(f, x, lb, ub,'Hold',true);
a00 = (1/sym(pi)) * int(f, x);
a0=release(a000);
ann = sym('an', [1 n]); % function
an= sym('an', [1 n]);  % evaluted the integral
a = sym('a', [1 n]);   % after substuting the limits

bnn = sym('bn', [1 n]);
bn = sym('bn', [1 n]);
b = sym('b', [1 n]);

for k = 1:n

    fprintf('a%d = \n',k)


    ann(k) = (1/sym(pi)) * int(f*cos(k*x), x, lb, ub,'Hold',true);
    disp(ann(k))
    an(k) = (1/sym(pi)) * int(f*cos(k*x), x);
    disp(an(k))
    disp("Substituting the Limits of integration We get")
    a(k)=release(ann(k));

    disp(a(k))

    fprintf('b%d = \n',k)

    bnn(k) = (1/sym(pi)) * int(f*sin(k*x), x, lb, ub,'Hold',true);
```

```
    disp(bnn(k))
    bn(k) = (1/sym(pi)) * int(f*sin(k*x), x);
    disp(bn(k))
    b(k)=release(bnn(k));
    disp("Substituting the Limits of integration ")
    disp(b(k))

    disp('-----------------------------------------------------------------------')
end
```

a1 =

$$\frac{\int_{-\pi}^{\pi} x^2 \cos(x)\, dx}{\pi}$$

$$\frac{\sin(x)\ (x^2 - 2) + 2\, x \cos(x)}{\pi}$$

Substituting the Limits of integration We get

$$-4$$

b1 =

$$\frac{\int_{-\pi}^{\pi} x^2 \sin(x)\, dx}{\pi}$$

$$-\frac{\cos(x)\ (x^2 - 2) - 2\, x \sin(x)}{\pi}$$

Substituting the Limits of integration

$$0$$

----

a2 =

$$\frac{\int_{-\pi}^{\pi} x^2 \cos(2\, x)\, dx}{\pi}$$

$$\frac{\frac{x \cos(2\, x)}{2} - \frac{\sin(2\, x)}{4} + \frac{x^2 \sin(2\, x)}{2}}{\pi}$$

Substituting the Limits of integration We get

$$1$$

b2 =

$$\frac{\int_{-\pi}^{\pi} x^2 \sin(2\, x)\, dx}{\pi}$$

$$\frac{\frac{x \sin(2\, x)}{2} + (2 \sin(x)^2 - 1) \left(\frac{x^2}{2} - \frac{1}{4}\right)}{\pi}$$

Substituting the Limits of integration

$$0$$

```
-----------------------------------------------------------------------
a3 =
```

$$\frac{\int_{-\pi}^{\pi} x^2 \cos(3\,x)\,\mathrm{d}x}{\pi}$$

$$\frac{\frac{2\,x\cos(3\,x)}{9} - \frac{2\sin(3\,x)}{27} + \frac{x^2\sin(3\,x)}{3}}{\pi}$$

```
Substituting the Limits of integration We get
```

$$-\frac{4}{9}$$

```
b3 =
```

$$\frac{\int_{-\pi}^{\pi} x^2 \sin(3\,x)\,\mathrm{d}x}{\pi}$$

$$\frac{\frac{2\,x\sin(3\,x)}{9} - \cos(3\,x)\left(\frac{x^2}{3} - \frac{2}{27}\right)}{\pi}$$

```
Substituting the Limits of integration
```

$$0$$

```
-----------------------------------------------------------------------
```

```
disp('final a and b vector is given below (a1,a2,.....) and (b1,b2,.....)')
```

```
final a and b vector is given below (a1,a2,.....) and (b1,b2,.....)
```

```
a
```

```
a =
```

$$\begin{pmatrix} -4 & 1 & -\frac{4}{9} \end{pmatrix}$$

```
b
```

b = $\begin{pmatrix} 0 & 0 & 0 \end{pmatrix}$

```
disp('---------------------------------------------------------------------')
```

```
-----------------------------------------------------------------------
```

```

disp('Graphing the actual function and Fourier series approximation')
```

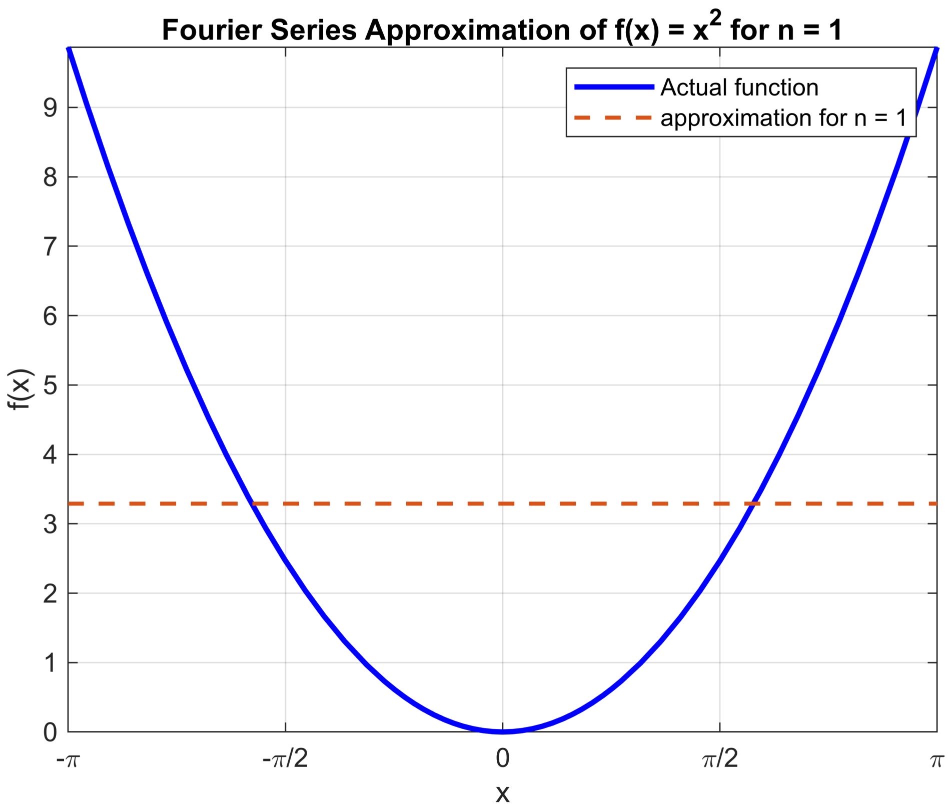
```
Graphing the actual function and Fourier series approximation
```

```

approximation = a0/2;
for k = 1:n
```

```
    approximation;
    fprintf('Approximation of f(x) for n = %d\n',k)
    disp(approximation)
    figure; % Create a new figure for each plot

    % Plot the actual function and Fourier series approximation
    fplot(f,[L,U],'b','LineWidth',2);
    hold on;
    fplot(approximation,[L,U],'LineWidth',1.5, 'LineStyle', '--');
    hold off;
    xlabel('x');

    vec= linspace(lb, ub, 5); % depending the gap required decide the spacing
    tick_labels = string(vec);

    % Replace "pi" with the LaTeX representation of the Greek letter pi
    tick_labels = replace(tick_labels, "pi", "\pi");

    xticks(linspace(L, U, 5)); %numel is like len() in python
    xticklabels(tick_labels);

    ylabel('f(x)');
    title(['Fourier Series Approximation of f(x) = ',char(f),' for n =
',num2str(k)]);
    legend('Actual function',['approximation for n = ',num2str(k)]);
    grid on;
    hold off;

    disp('----------------------------------------------------------------------')

    approximation = approximation + a(k)*cos(k*x) + b(k)*sin(k*x);

end
```

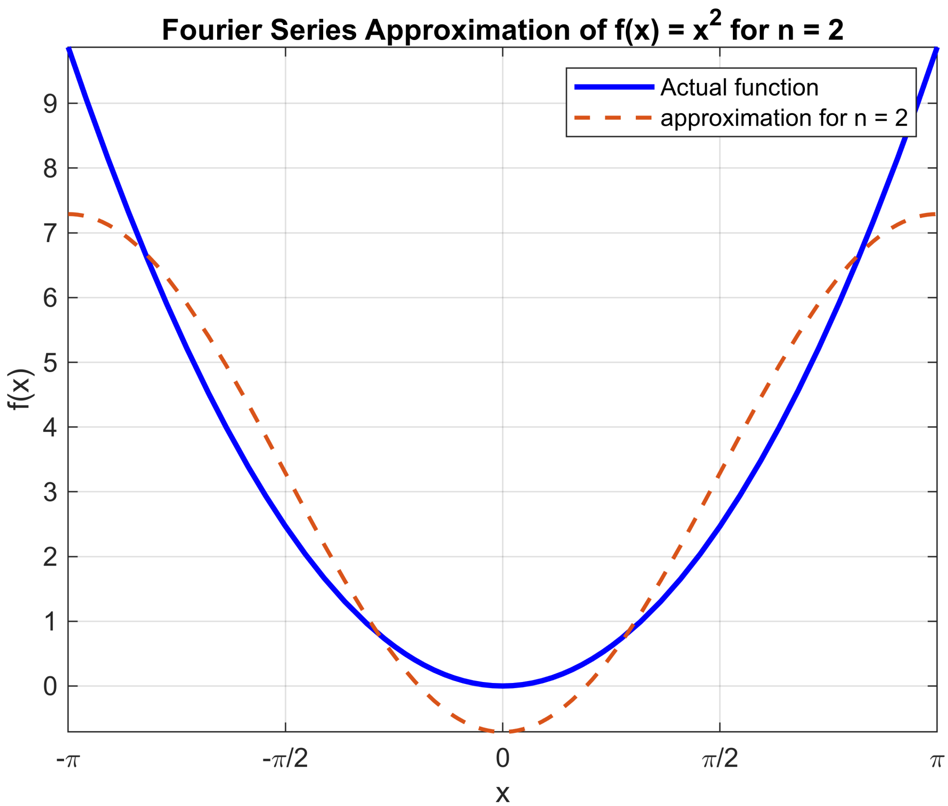
```
Approximation of f(x) for n = 1
```

$$\frac{\pi^2}{3}$$



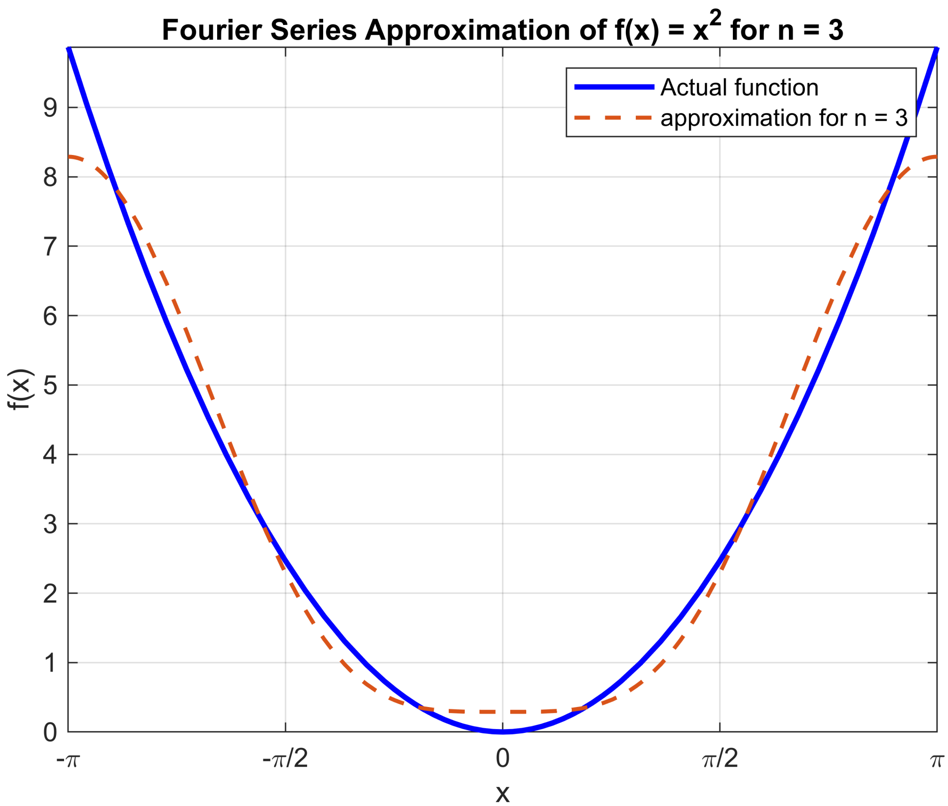
Approximation of f(x) for n = 2

$$\frac{\pi^2}{3} - 4\cos(x)$$




```
--------------------------------------------------------------------
Approximation of f(x) for n = 3
```

$$\cos(2\,x) - 4\cos(x) + \frac{\pi^2}{3}$$


Fourier Series Approximation of f(x) = x^2 for n = 3
Actual function
approximation for n = 3
f(x)
x
-π
-π/2
0
π/2
π
0
1
2
3
4
5
6
7
8
9
