

# MathEng2122

December 10, 2024

## *Mathematical Methods for Engineers (MathEng)*

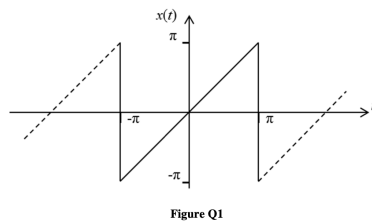
### EXAM

December 2021

Duration: 2 hrs, all documents and calculators permitted

ATTEMPT ALL QUESTIONS - ANSWER IN ENGLISH

- 1 Determine an expression for the complex Fourier series of the periodic sawtooth waveform illustrated in Figure Q1.



[6 marks]

```
[1]: using FFTW, LinearAlgebra, Plots, LaTeXStrings
```

```
[2]: include("../modules/operations.jl");
```

```
[3]: # Define the Fourier coefficients C_k
function C_k(k)
    if k == 0
        return 0.0 # C_0 is zero for the sawtooth signal
    else
        return (j * k * (^ (2j * k) + 1) - (^ (2j * k) - 1)) / (2 * j * k^2) * ^(-j * k)
    end
end

# Define the Fourier series reconstruction
function sawtooth_reconstruction(t, N)
    (real(C_k(k) * ^(j * k * t)) for k in -N:N)
end
```

```

# Original sawtooth function
function sawtooth_original(t)
    t
end

```

[3]: sawtooth\_original (generic function with 1 method)

```

[4]: # Time range for visualization
T = 2 # Period
t = -2:0.01:2 # Time values for one period

# Number of terms in Fourier series
N = 50 # Adjust for higher accuracy

# Plot the original and reconstructed signals

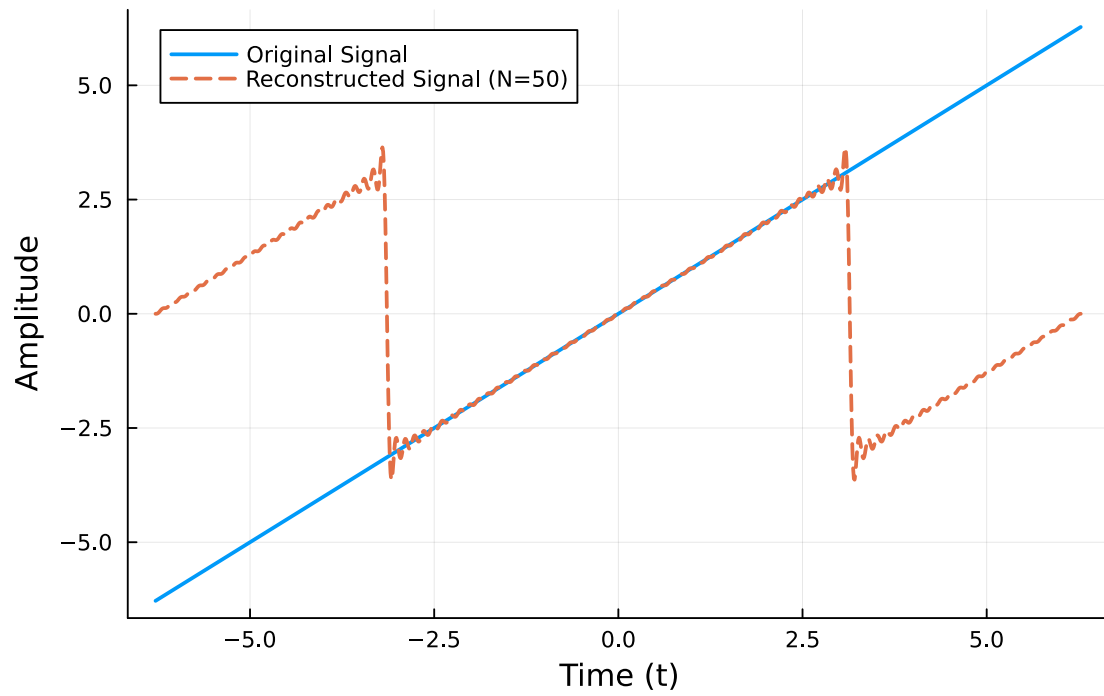
# Original signal
plot(t, [sawtooth_original(t) for t in t]
      , label="Original Signal", lw=2
      , title = "Fourier Series Reconstruction of Sawtooth Wave"
      , xlabel = "Time (t)", ylabel = "Amplitude"
)

# Reconstructed signal
plot!(t, [sawtooth_reconstruction(t, N) for t in t]
      , label="Reconstructed Signal (N=$N)", lw=2, linestyle=:dash
)

```

[4]:

## Fourier Series Reconstruction of Sawtooth Wave



[ ]:

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