S16036

CPL 106

1. Basic of Sinewave signals

I. $y(t) = A \sin(2\pi Ft + \phi)$

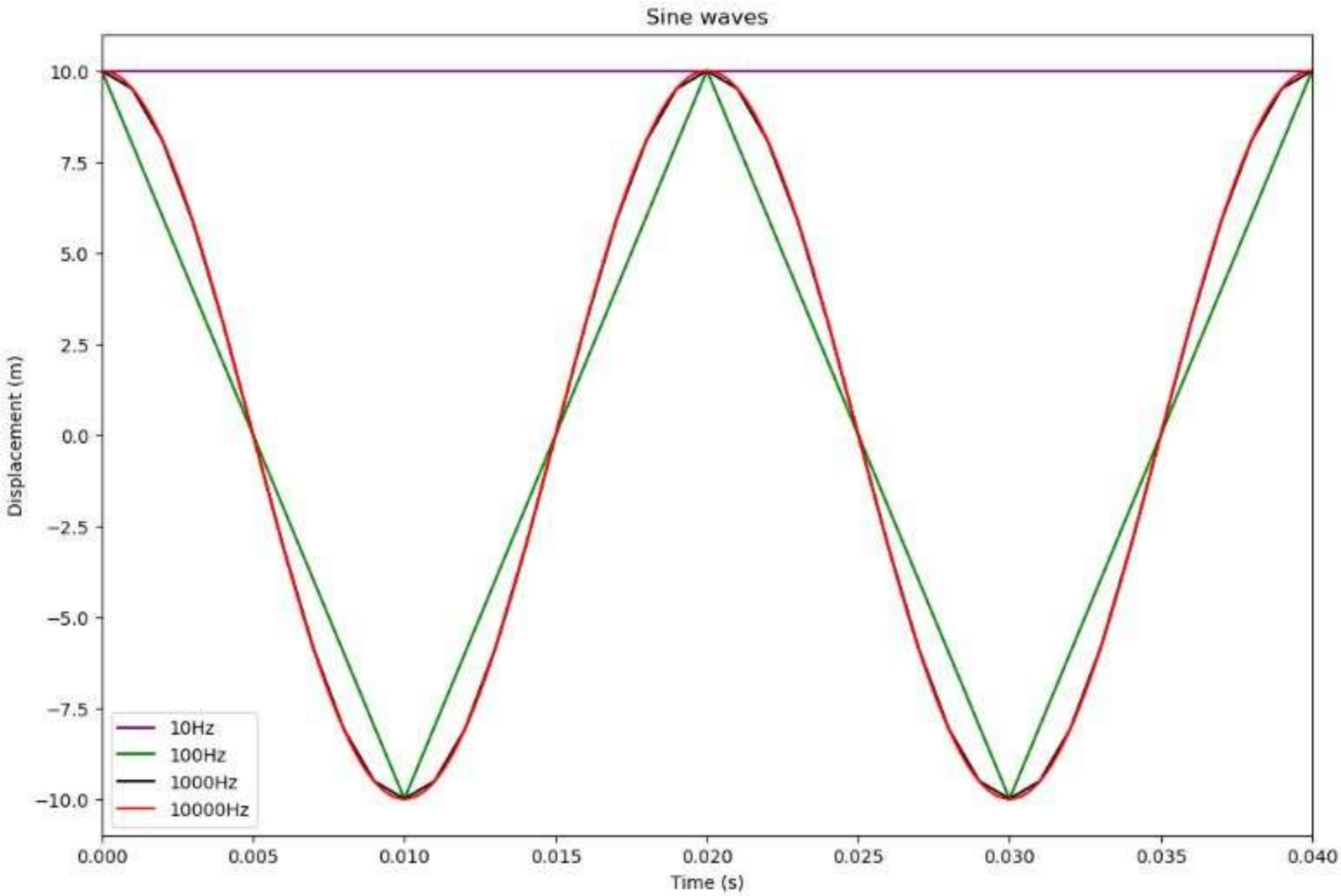
A – Amplitude of the sine wave
F – Frequency of the sine wave
t – time
$\emptyset - phase\ change$

II. $T = \frac{1}{f}$

III. $T = \frac{1}{f}$

IV. Sampling rate is the number of samples taken from a continuous signal per second to create a digital signal. So, when the sampling rate increases it allows for more accurate capture of peak values and signal detail which can lead to better resolution and lesser distortion. It would be more accurate the stored information and the signal reconstruction from its samples. However, high sampling rate produces a large volume of data to be stored and makes necessary the use of a very fast analog-to-digital converter.

V.


Sine waves
10.0
7.5
5.0
2.5
0.0
−2.5
−5.0
−7.5
−10.0
Displacement (m)
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0.035
0.040
Time (s)
10Hz
100Hz
1000Hz
10000Hz

2. Discrete Fourier Transform (DFT)

I. Time domain signal processing analyzes the input signal depending on the waveforms observed over a period of time. Time domain techniques emphasize the amplitude variation in a specific time. This has many applications in speech processing and heavy vehicle classification. Time is represented in the x axis and amplitude is represented in the y axis

II. Frequency domain is an analysis of signals in reference to frequency, instead of time. Frequency domain explains how much of the signal exists within a given frequency band concerning a range of frequencies.
Fourier transformation converts a time function into an integral of sine waves of various frequencies or sum, each of which symbolizes a frequency component.

III.
The main difference between Continuous Fourier Transformation (CFT) and Discontinuous Fourier Transformation (DCFT) is that CTFT is used for continuous time signals, while the DFT is used for discontinuous time signals.

Continuous Fourier Transformation (CFT)	Discontinuous Fourier Transformation (DCFT)
used for continuous time signals and aperiodic signals	used for discontinuous time signals and
Produces a continuous and aperiodic frequency domain	Produces a periodic frequency domain
Extends over an infinite frequency range	Defined by its behavior over a frequency range of 2π

a.) How does the Fourier Transform convert a discrete signal from the time domain to the frequency domain? Provide an expression.

$$X_k = \sum_{n=0}^{N-1} x_n e^{\frac{-j2\pi}{N}kn}$$

N – number of samples
n – current sample
k – current frequency
x_n – sine value of the nth sample
X_k – DFT value

b.) How does the Fourier Transform convert a continues signal from the time domain to the frequency domain? Provide an expression.

$$X_f = \int x_t e^{-j2\pi ft} dt$$

N – number of samples

f – current frequency

x_t – sine value of the n^{th} sample

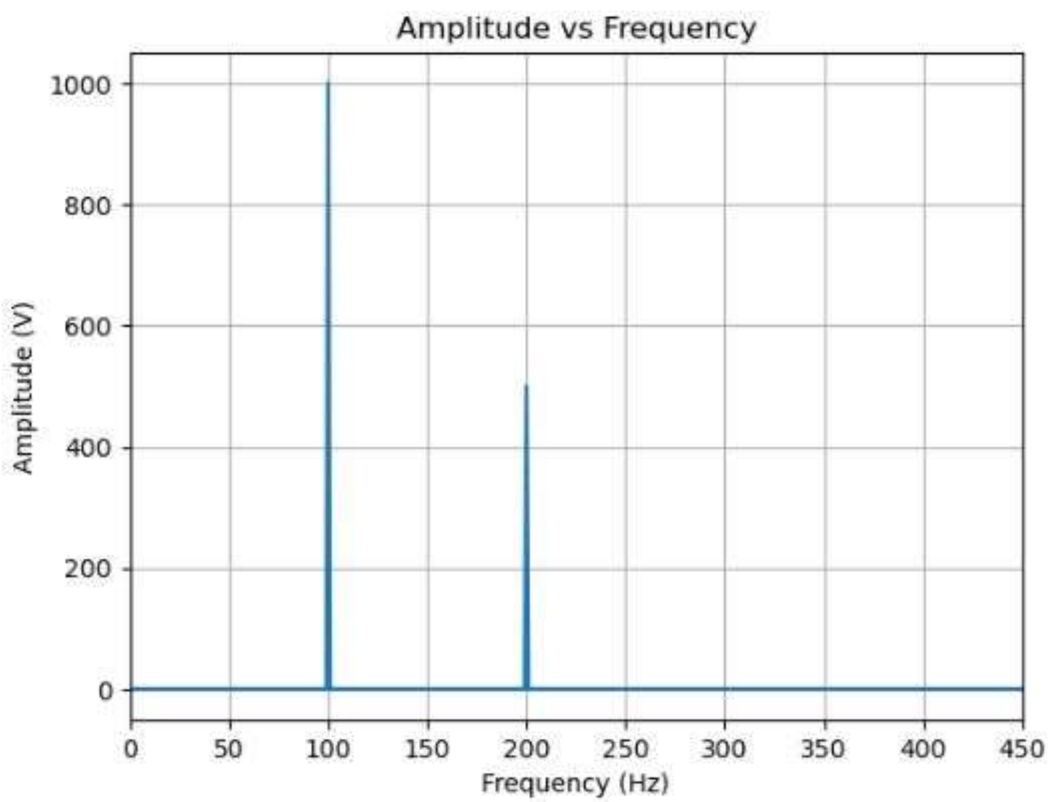
X_f – CFT value

t– time

3. Fast Fourier Transform (FFT)

I. Fast Fourier Transform (FFT) is more efficient than Discrete Fourier Transform (DFT).
FFT uses lesser memory than DFT
Algorithm of FFT is simpler than DFT as it breaks down the DFT into small sub parts.

II.



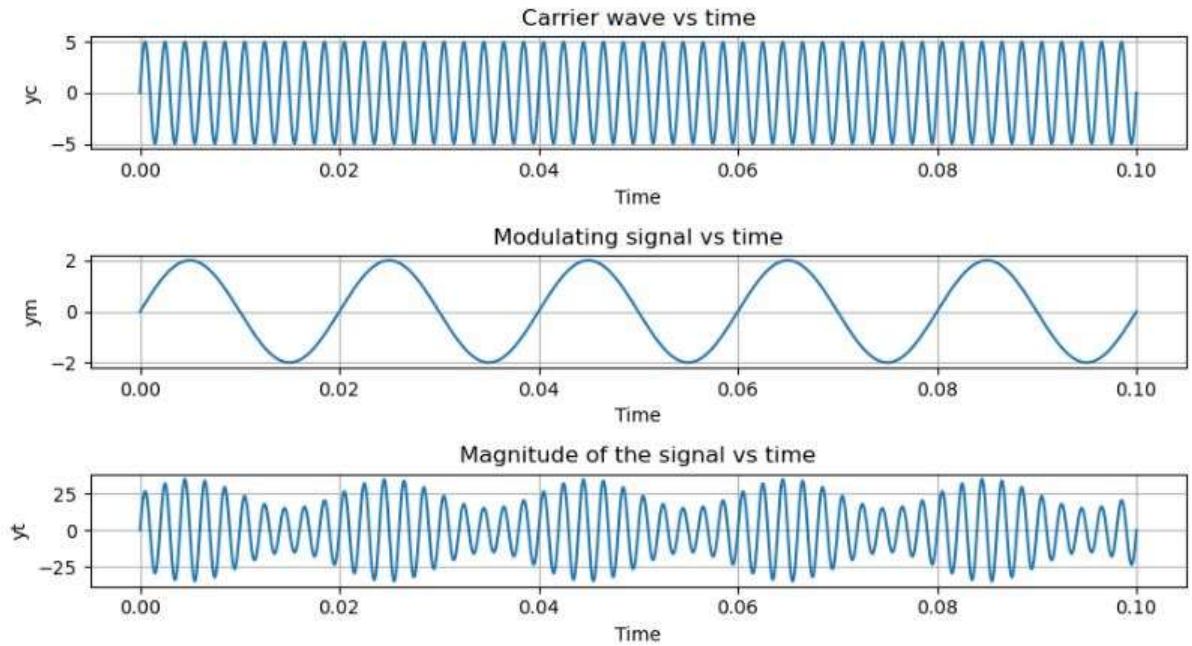
III.

a.) $y_c(t) = 5\sin(2\pi \times 500 \times t)$

b.) $y_m(t) = 2\sin(2\pi \times 50 \times t)$

c.) $y(t) = (5 + 2\sin(2\pi \times 50 \times t)) \times 5\sin(2\pi \times 500 \times t)$

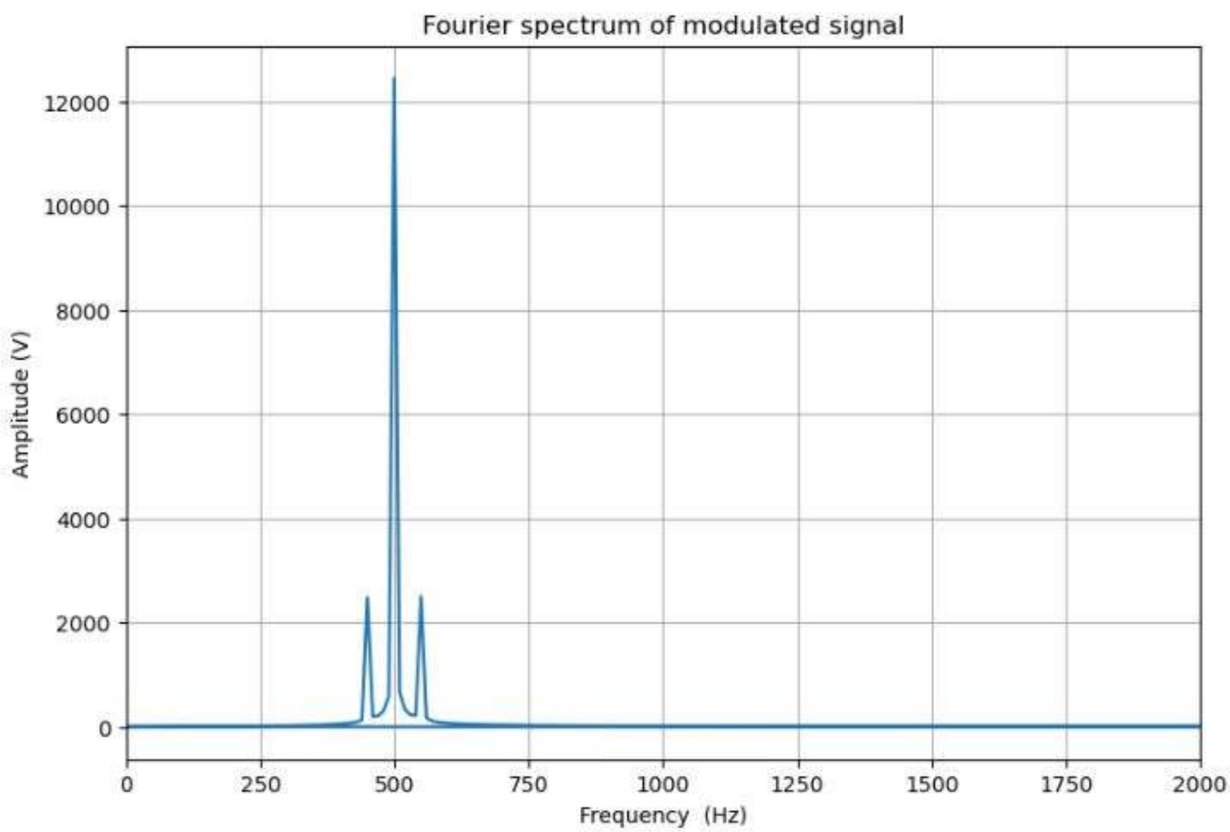
d.)



Carrier wave vs time
yc
5
0
−5
0.00
0.02
0.04
0.06
0.08
0.10
Time
Modulating signal vs time
ym
2
0
−2
0.00
0.02
0.04
0.06
0.08
0.10
Time
Magnitude of the signal vs time
yt
25
0
−25
0.00
0.02
0.04
0.06
0.08
0.10
Time

e.)

i.)



Fourier spectrum of modulated signal
Amplitude (V)
12000
10000
8000
6000
4000
2000
0
0
250
500
750
1000
1250
1500
1750
2000
Frequency (Hz)

```
ii.
Lowest frequency =  0.0 Hz

iii.
Highest frequency =  499.5 Hz

iv.
Bandwidth =  499.5 Hz
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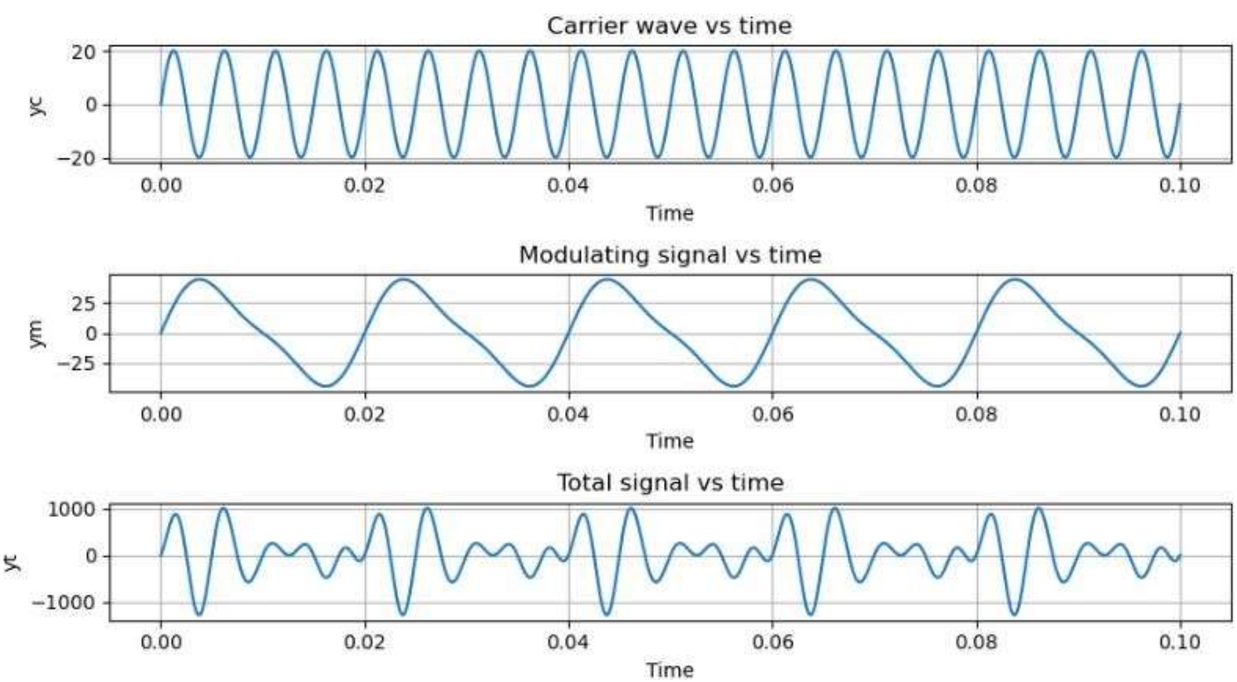
IV.)

a.)

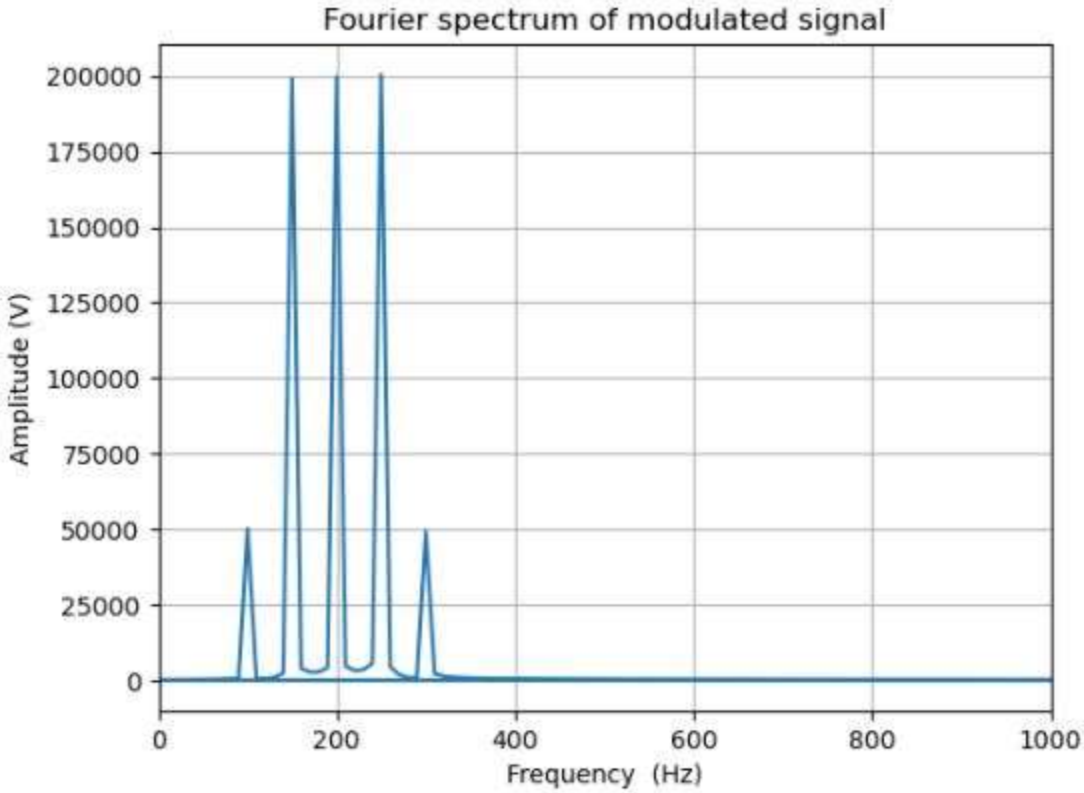
$$y(t) = 20\sin(400\pi t)\,(10\sin(200\pi t) + 40\sin(100\pi t))$$

b.)



c.)

i.



ii.
Lowest frequency = 0.0 Hz

iii.
Highest frequency = 249.75 Hz

iv.
Bandwidth: 249.75 Hz