Advanced Functions, Grade 12 (MHF4U)
Course Description

Course Title: Advanced Functions
Course Code: MHF4U
Grade: 12
Course Type: University
Credit Value: 1.0
Prerequisite: MCR3U

- **This course builds on** your knowledge from grade 11 University mathematics
- **It leads you** on a direct path to University or Calculus & Vectors and may be taken concurrently with MCV4U
- **This can lead you to many careers such as:** Aviation Technician, Child Life Specialist, Forensic Scientist, Music Publisher

Official Ontario Ministry of Education secondary curriculum available here:
http://www.edu.gov.on.ca/eng/curriculum/secondary/math.html

This course has four main strands:

Exponential and Logarithmic Functions

Trigonometric Functions

Polynomial and Rational Functions

Characteristics of Functions

Exponential & logarithmic functions:

Students will explore the algebraic and graphical properties of exponential and logarithmic functions and solve equations that involve the use of exponents and logarithms. They will apply this knowledge to real-life situations, such as calculating the intensity of earthquakes.

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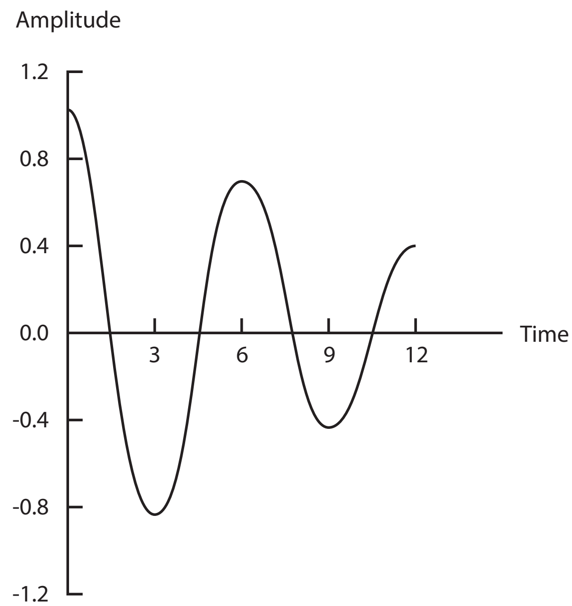
Trigonometric functions:

Students will develop a deep understanding of trigonometric functions and their applications to real-life scenarios, such as modelling the motion of a damped pendulum. They will develop this understanding by studying the algebraic and graphical properties of trigonometric functions. Students will also solve equations using trigonometric ratios and identities.



Lightly Damped System

Examine the graph. What is happening over time?

Polynomial & rational functions:

Students will study the algebraic and graphical properties of polynomial and rational functions. They will also solve polynomial and rational functions and apply these skills to real-life applications, such as calculating the strength of gravity acting on an object from a distance.

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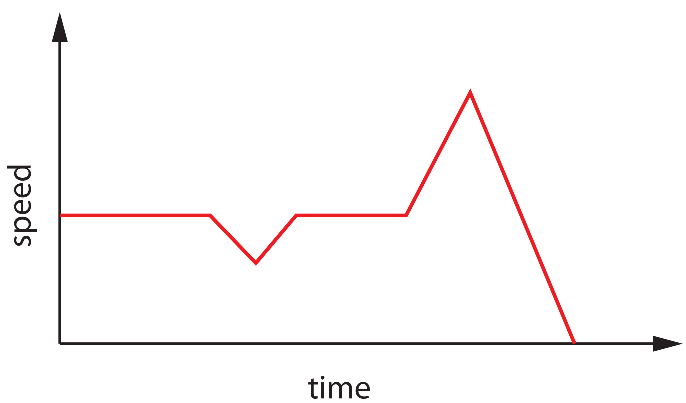
Characteristics of functions:

Students will demonstrate an understanding of average and instantaneous rates of change. They will determine the functions that result from adding, subtracting, multiplying and dividing two functions. They will compare the characteristics of different functions and solve problems by modelling and reasoning with functions, including problems with solutions that are not accessible by standard algebraic techniques by solving problems like this:

> John rides his bicycle at a constant cruising speed along a flat road. He then decreases speed as he climbs a hill. At the top, he increases speed on a flat road to resume his constant cruising speed, and then accelerates down a hill. Finally, he comes to another hill and glides to a stop as he starts to climb. Sketch a graph of John's speed versus time.



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The following problems can be solved using knowledge from more than one strand in the course.

Problem 1: Explain why a rock concert which is measured at 120 dB loud is not 30 x louder than a train which is measured at 90 dB.

L represents loudness in dB (decibels)
I represents intensity of sound measured

$$L = 10 \log \frac{I}{I_0}$$

Io represents intensity of sound at threshold of hearing

Solution 1:

Rock Concert

$$120 = 10 \log \frac{I_{RC}}{I_0}$$

$$\frac{120}{10} = \frac{10 \log}{10} \frac{I_{RC}}{I_0}$$

$$12 = \log \frac{I_{RC}}{I_0}$$

$$10^{12} = \frac{I_{RC}}{I_0}$$

$$10^{12} I_0 = I_{RC}$$

Train

$$90 = 10 \log \frac{I_T}{I_0}$$

$$\frac{90}{10} = \frac{10 \log}{10} \frac{I_T}{I_0}$$

$$9 = \log \frac{I_T}{I_0}$$

$$10^{9} = \frac{I_T}{I_0}$$

$$10^{9} I_0 = I_T$$

Compare Train to Concert

$$= \frac{I_{RC}}{I_T}$$

$$= \frac{10^{12}}{10^{9}}$$

$$= 10^{3}$$

∴ the rock concert is100× more intense (louder) than the train.

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Problem 2: A charge nurse is responsible for determining the concentration of a drug for their patient. The concentration (ppm) of the drug in the patients' blood stream is modelled with the function

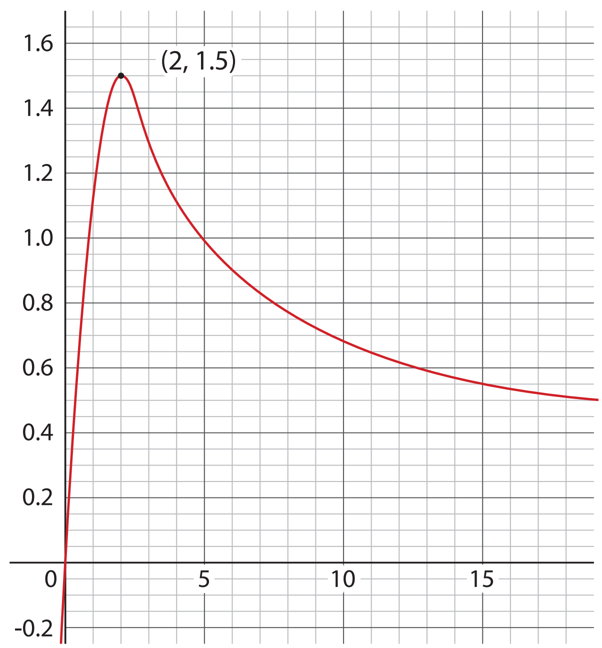
$$C(t) = \frac{6t}{t_2 + 4}$$ where *t* represents the elapsed time in hours after injection

Determine at what time the drug will be at maximum concentration and what concentration will be.

Determine at what time the drug will fall below a concentration of 0.6 ppm. Calculate the rate of change of the concentration at 10 hours.

Solution 2:

Using graphing software the following graph was produced:



The drug reaches a maximum of 2.0 ppm after 1.5 hours of time elapsed. The drug drops under 0.6 ppm at approximately 9.5 hours.

Calculate the instantaneous rate of change at 10 hours

Instantaneous rate of change (R.O.C.) at 10 hours

$$\text{R.O.C.} = \frac{f(a+h) - f(a)}{h} \qquad f(a) = \frac{6a}{a^2 + 4}$$

$$\text{R.O.C.} = \frac{f(10 + 0.001) - f(10)}{0.001}$$

$$\text{R.O.C.} = \frac{\left(\frac{6\,(10.001)}{10.001^2 + 4}\right) - \left(\frac{6\,(10)}{10^2 + 4}\right)}{0.001}$$

$$\text{R.O.C.} = \frac{-0.00005}{0.001}$$

$$\text{R.O.C.} = -0.05$$

At 10 hours the instantaneous R.O.C. is -0.05 ppm/hour, so the amount of drug in the blood stream is decreasing 0.05 ppm/hour.