# LOTI.05.019 Data Analysis and Computational Methods with MATLAB
# Seventh Practical Session

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### 1. Question 1

Write a user-defined MATLAB function that converts speed given in units of knots (one knot is one nautical mile per hour) to speed in units of feet per second. For the function name and arguments, use `fps=ktsTOfps(kts)`. The input argument `kts` is the speed in knots, and the output argument `fps` is the speed in ft/s. Use the function to convert 400 kts to units of ft/s.

### 2. Question 2

The Taylor's series expansion for cos$x$ about $x = 0$ is given by:

$$\cos x = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} + \cdots = \sum_{n=0}^{\infty} \frac{(-1)^n}{(2n)!} x^{2n} \tag{1}$$

where $x$ is in radians. Write a user-defined function that determines $\cos x$ using Taylor's series expansion. For function name and arguments, use `y=cosTay(x)`, where the input argument `x` is the angle in degrees and the output argument `y` is the value for $\cos x$. Inside the user-defined function, use a loop for adding the terms of the Taylor's series. If $a_n$ is the $n$th term in the series, then the sum $S_n$ of the $n$ terms is $S_n = S_{n-1} + a_n$. In each pass, calculate the estimated error $E$ given by $E = \left|\frac{S_n - S_{n-1}}{S_{n-1}}\right|$. Stop adding terms when $E \leq 0.000001$. Since $\cos(\theta) = \cos(\theta \pm 360n)$ write the user-defined function such that if the angle is larger than 360°, or smaller than -360°, then the Taylor series will be calculated using the smallest number of terms (using a value for $x$ that is closest to 0).
Use `cosTay` for calculating:

- $\cos 67°$
- $\cos 200°$
- $\cos -80°$
- $\cos 794°$
- $\cos 20000°$
- $\cos -738°$

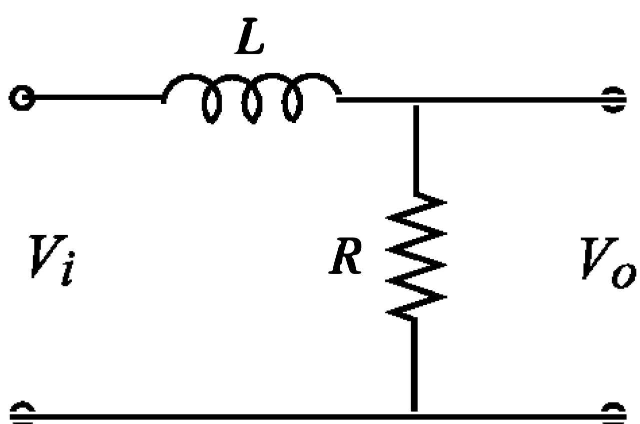
Compare the values calculated using `cosTay` with the values obtained by using MATLAB's built-in `cosd` function.

3. **Question 3**

In a low-pass RL filter (a filter that passes signals with low frequencies), the ratio of the magnitudes of the voltages is given by:

$$RV = \left|\frac{V_o}{V_i}\right| = \frac{1}{\sqrt{1 + \left(\frac{\omega L}{R}\right)^2}} \tag{2}$$

where $\omega$ is the frequency of the input signal.
Write a user-defined MATLAB function that calculates the magnitude ratio. For the function name and arguments, use `RV=LRFilt(R,L,w)`. The input arguments are `R`, the size of the resistor in $\Omega$ (ohms); `L`, the size of the capacitor in H (Henry); and `w`, the frequency of the input signal in rad/s. Write the function such that `w` can be a vector.
Write a program in a script file that uses the `LRFilt` function to generate a plot of $RV$ as a function of $\omega$ for $10 \leq \omega \leq 10^6$ rad/s. The plot has a logarithmic scale on the horizontal axis ($\omega$). When the script file is executed, it asks the user to enter the values of $R$ and $L$. Label the axes of the plot.
Run the script file with $R = 600\ \Omega$, and $L = 0.14\ \mu$F.




4. **Question 4**

A circuit that filters out a certain frequency is shown in the figure. In this filter, the ratio of the magnitudes of the voltages is given by:

$$RV = \left|\frac{V_o}{V_i}\right| = \frac{|R\,(1 - \omega^2 LC)|}{\sqrt{(R - R\omega^2 LC)^2 + (\omega L)^2}} \tag{3}$$

where $\omega$ is the frequency of the input signal.
Write a user-defined MATLAB function that calculates the magnitude ratio. For the function name and arguments, use `RV=filtfreq(R,C,L,w)`. The input arguments are `R` the size of the resistor in $\Omega$ (ohms); `C`, the size of the capacitor in F (farads); `L`, the inductance of the coil in H (henrys); and `w`, the frequency of the input signal in rad/s. Write the function such that `w` can be a vector.
Write a program in a script file that uses the `filtfreq` function to generate a plot with

two graphs of RV as a function of $\omega$ for $10 \le \omega \le 10^4$ rad/s. In one graph $C = 160\ \mu$F, $L = 45$ mH, and $R = 200\ \Omega$, and in the second graph $C$ and $L$ are the same and $R = 50\ \Omega$. The plot has a logarithmic scale on the horizontal axis ($\omega$). Label the axes and display a legend.