1. (a) Explain how the transfer function is defined. Explain also what kind of information can be obtained from the transfer function.

(b) Consider the following circuit. Assume ideal operational amplifier and analyze $V_0$ as function of $V_1$ and $V_2$. Based on your result, how would you characterize the connection.

![Circuit Diagram](image)

2. (a) Find the transfer function $\frac{U_2}{U_1}$ for the following case. Let $C = 1\text{F}$, $L = 1\text{H}$, $R = 1\Omega$. Find value for the transfer function when $\omega = 0$ and $\omega = \infty$. How would you reason the results.

![Circuit Diagram](image)

(b) Find the Taylor polynomial of degree 4 for $f(x) = \sin(x)$.

3. (a) The switch in the circuit below is closed at $t = 0$, the capacitor has at that moment charge $Q_0 = 500\mu\text{C}$ (whose polarity is as in the picture). Obtain $i$ and charge $q$ in the capacitor for $t > 0$, also sketch the graph of $q$.

![Circuit Diagram](image)

(b) Describe how the directional derivative is defined, reason also why and where such a construction could be needed.

TURN OVER
4. (a) In the Gram–Schmidt process we encounter terms like \( \frac{\langle f_k, g \rangle}{\langle f_k, f_k \rangle} f_k \) where \( f_k, g \) are scalar functions and

\[
\langle f, g \rangle = \int_a^b f g dx
\]

defines an inner product for functions in the interval \([a, b]\). Explain how to interpret this kind of terms.

(b) Consider the plot below, it is obtained using Matlab and the Fourier tools. Describe it briefly. Suppose that you would need to get rid of the first two peaks. Form a (as simple as possible) circuit, include also possible values for components of the circuit.

![Graph showing amplitude vs frequency with peaks at certain frequencies.](image-url)