1) Four (4) resistors, \( R_1, R_2, R_3, \) and \( R_4 \), each having the same nominal value \( R \) and the same ± precision, are used in the design for the 4:1 voltage divider shown below. If the divider ratio is specified to be \( \frac{v_{\text{out}}}{v_{\text{in}}} = 0.25 \) with a precision of ±3%, use worst-case analysis to determine the requirement on the ±% precision for the four resistors.

![Voltage Divider Circuit](attachment:image)

2) The steady-state AC voltage & current sources in the circuit below operate at different frequencies: \( f_1 \) and \( f_2 \) in Hz, that is:

\[
v_s(t) = V_o \cos(2\pi f_1 t) \quad \text{&} \quad i_s(t) = I_o \sin(2\pi f_2 t).
\]

(a) Find a time-dependent, algebraic expression for the AC voltage across the resistor \( v_R(t) \). (b) In a few well-written sentences, summarize the linear circuit principles used to solve this problem.

![AC Circuit](attachment:image)
3) Using phasors, solve the equation below for steady-state AC voltage \( v(t) \).

\[
\frac{d^2v}{dt^2} + 2 \frac{dv}{dt} + v = \cos(t + \varphi / 4)
\]

4) A step change of voltage from \( V_1 \) to \( V_2 \) occurs at \( t = 0 \) to the RLC circuit shown below. (a) Replicate the table below in your exam booklet and then fill it in with algebraic expressions for the various voltages and currents at the times given. (b) Explain concisely and clearly how these answers were obtained.

<table>
<thead>
<tr>
<th>( t = 0_\pm )</th>
<th>( t = 0_+ )</th>
<th>( t \rightarrow \infty )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( v_{LC}(t) )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( i_L(t) )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( i_C(t) )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( i(t) )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( v_R(t) )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5) Consider the circuit below. (a) At frequency \( f = 100 \) kHz, find numerical values for the real & imaginary parts of the complex impedance \( Z(f) \), that is, \( R(f) \) and \( X(f) \), where \( Z(f) = R(f) + jX(f) \). Do not overstate precision and be sure to specify units. (b) What is the frequency in Hertz at which \( X = 0 \)?

\[
\begin{align*}
R_1 & = 5 \, k\Omega \\
R_2 & = 10 \, k\Omega \\
C & = 500 \, pF \\
L & = 10 \, mH
\end{align*}
\]

6) Find the Thevenin equivalent in the frequency domain for the AC circuit shown below. Explain your methods.

\[
V_o \cos(\omega t - \pi/3)
\]

7) At \( t = 0 \), a step voltage \( V_o \) is applied to the series RC circuit shown below. (a) Find time-dependent expressions for (a) the electric current \( i(t) \) and (b) the voltage across the capacitor \( v_c(t) \). (c) What is the total stored energy of the circuit \( w(t) \) as a function of time?
8) Consider the twin-T AC filter circuit shown below. (a) How many nodes with *independent* unknown voltages are there? (b) Sketch the circuit in your exam booklet and in this sketch clearly identify these nodes and define voltages for them. (c) Use nodal analysis to obtain a complete set of independent equations for these voltages. DO NOT SOLVE FOR THESE VOLTAGES.