

- 1 2 inductors of 2H and 5H are in series.
 - (a) What is the range of values their collective impedance can take as their mutual inductive coupling coefficient k varies from 0 to 1 and M is allowed to be both positive and negative at $\omega = 100\pi\text{rad/s}$.
 - (b) Is it possible, at any frequency, for any valid value of k and for any sign for M that the system can exhibit negative (capacitive) reactance?
- 2 Repeat all the parts of Q.1 if the same inductors are in parallel.
- 3 Can mutual inductance be handled and studied as dependent sources? Take Fig.3 below as an example. $V_1 = 40/30^\circ\text{V}$; $V_2 = 65/-75^\circ\text{V}$; $\omega = 100\text{rad/s}$ for both, $L_1 = 0.2\text{H}$, $L_2 = 0.8\text{H}$, $R_1 = 50\Omega$, $R_2 = 600\Omega$, $C_1 = 0.8\mu\text{F}$, $C_2 = 2\mu\text{F}$. Suppose L_1, L_2 are mutually coupled by $k = 3/4$. Instead of treating this as a mutual inductance phenomenon, we want to depict the observed behaviour as the result of the presence of dependent sources.
 - (a) What sort of dependent sources are to be used? V dependent I sources? I dependent V sources? I dependent I sources? V dependent V sources? Justify. (confine your arguments to the context of sinusoidal steady state 'phasor' analysis at a known frequency)
 - (b) Suppose the dots on both L_1 and L_2 are to the left side. Redraw the circuit with the dots removed and with the proper dependent sources introduced. Repeat for the other three cases for different dot locations (both dots to the right, dot on L_1 to the right, dot on L_2 to the left and dot on L_1 to the left, dot on L_2 to the right).
 - (c) Take $V_2 = 0$. Find the choice of dot convention (dot positions) for the mutual inductance between L_1, L_2 that will ensure the maximum magnitude of impedance seen from the source.

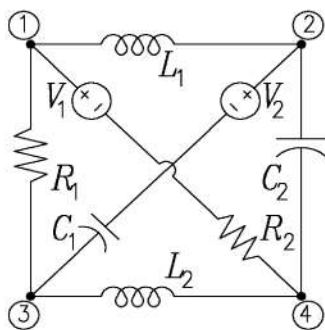


Fig.3

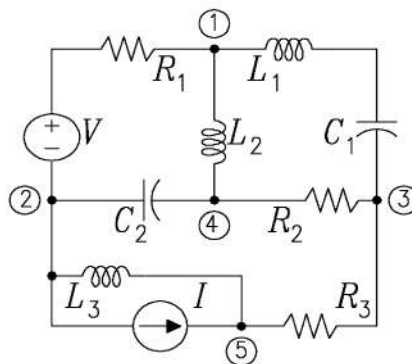


Fig.4

- 4 (a) For Fig.4, write out the three mesh equations taking all inner mesh current clockwise. The self and mutual inductances between L_1, L_2, L_3 are given in the form of the following matrix where all entries are in mH:

$$\mathbf{L} = \begin{bmatrix} 500 & -200 & -500 \\ -200 & 400 & 250 \\ -500 & 250 & 1000 \end{bmatrix}$$

- (b) For the given inductance matrix, evaluate the different coupling coefficients and the appropriate dot conventions and draw the circuit to show the couplings and the dot positions.