$$v = (\hat{j}\omega L_1) i + \hat{j}\omega M i + (\hat{j}\omega L_2) i + \hat{j}\omega M i$$

$$v = i(\hat{j}\omega L_1 + \hat{j}\omega L_2) + \hat{j}\omega(2M) i \quad \text{--- (3)}$$

$$i = \frac{v}{\hat{j}\omega(L_1 + L_2 + 2M)} \quad \text{--- (4)}$$

If the dot one one coil were reversed, the sign of the mutual term either in eqn (2) or in eqn (3) would be <u>minus</u>

Therefore, equivalent inductance of two mutually coupled coils connected in series is

$$L_{eq} = L_1 + L_2 \pm 2M \quad \text{--- (5)}$$

Since the net inductance must be positive,

$$L_1 + L_2 \geq 2M \quad \text{--- (6)}$$

September'11

| | | | | | |
|---|---|---|---|---|---|
| Monday | | 5 | 12 | 19 | 26 |
| Tuesday | | 6 | 13 | 20 | 27 |
| Wednesday | | 7 | 14 | 21 | 28 |
| Thursday | 1 | 8 | 15 | 22 | 29 |
| Friday | 2 | 9 | 16 | 23 | 30 |
| Saturday | 3 | 10 | 17 | 24 | |
| Sunday | 4 | 11 | 18 | 25 | |

Notes

Appointment

# TWO COILS ARE IN PARALLEL

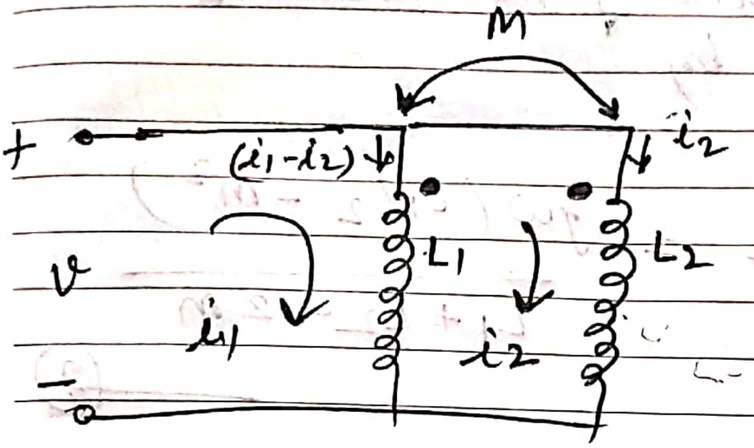


fig: Time domain ckt

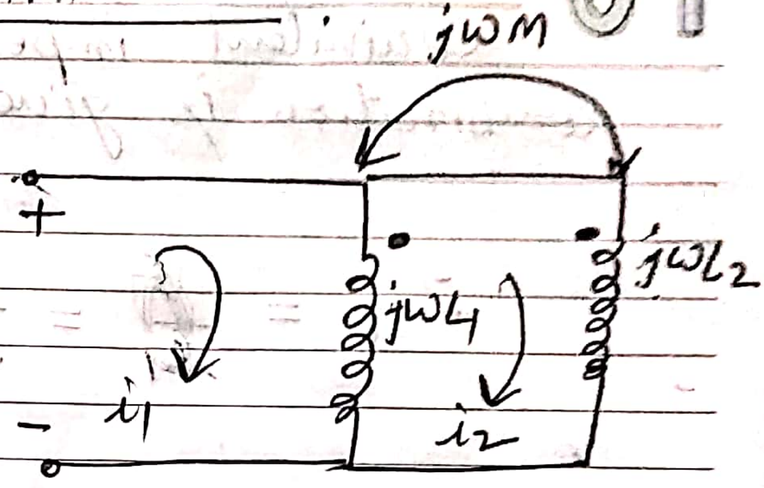


fig: frequency domain ckt.

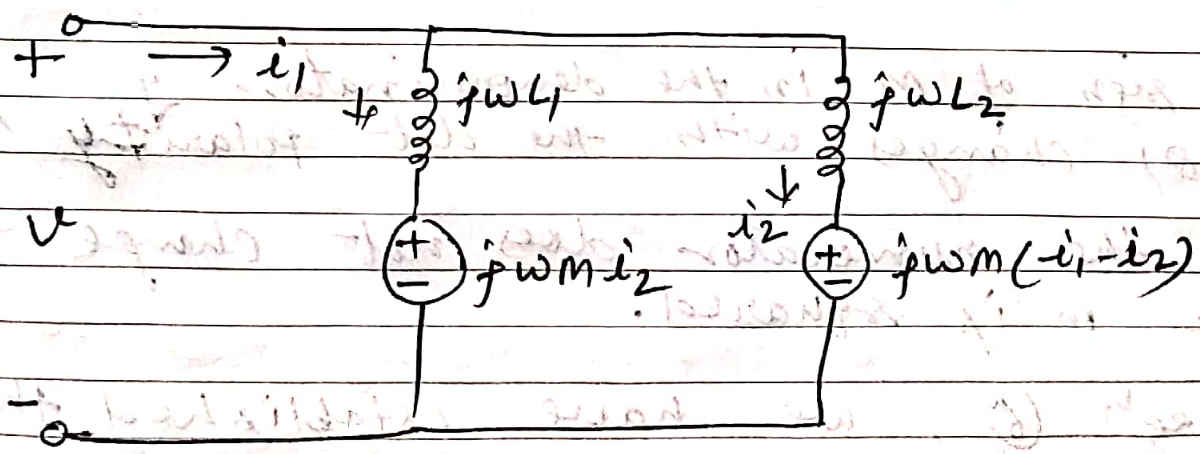


fig: Circuit with mutual-inductance voltage generator.



Notes

Appointment

November'11

| | | | | | |
|---|---|---|---|---|---|
| Monday | | 7 | 14 | 21 | 28 |
| Tuesday | 1 | 8 | 15 | 22 | 29 |
| Wednesday | 2 | 9 | 16 | 23 | 30 |
| Thursday | 3 | 10 | 17 | 24 | |
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| Sunday | 6 | 13 | 20 | 27 | |

equivalent impedance of the Parallel combination is given by

$$Z_{eq} = \frac{V}{i_1} = \frac{j\omega(L_1L_2 - M^2)}{L_1 + L_2 - 2M} \quad (7)$$

equivalent inductance

$$L_{eq} = \frac{(L_1L_2 - M^2)}{(L_1 + L_2 - 2M)} \quad (8)$$

The sign of M in the denominator of eq^n (8) changes with the dot polarity, but the numerator does not change since M is squared.

In eq^n (8), we have established that the

$$\boxed{L_1 + L_2 \geq 2M}$$

since overall inductance must be positive

$$L_1L_2 - M^2 \geq 0 \quad (9)$$

from eqn (6)

$$M \leq \left(\frac{L_1+L_2}{2}\right) \qquad (10)$$

from eqn (9)

$$M \leq \sqrt{L_1 L_2} \qquad (11)$$

eqn (10) states that the mutual inductance must be less than the arithmatic mean of $L_1$ and $L_2$,

while eqn (11) states that the mutual inductance must be less than the geometric mean of $L_1$ and $L_2$.

But

(geometric mean of $L_1$ and $L_2$) less than (the arithmetic mean of $L_1$ and $L_2$)

$$\sqrt{L_1 L_2} \leq \frac{L_1+L_2}{2}$$

$$L_1 = L_2$$

except when the two inductances are equal.



maximum value of mutual inductance is

$$M_{max} = \sqrt{L_1 L_2} \qquad (12)$$

from eqn (11)

$$\frac{M}{\sqrt{L_1 L_2}} \leq 1 \quad \text{—— (13)}$$

Let us define,

$$K = \frac{M}{\sqrt{L_1 L_2}} = \text{coupling coefficient}$$

$$0 \leq K \leq 1$$

physical meaning of $K = 1$ is that all the flux produced by the current in one of the coils links the other.

Iron-core Transformer ⟹ $K \approx 1.0$

Air-core coils ⟹ $K << 1.0$ (Very small)