### Capacitive Reactance

#### For capacitor the current $I_C$ leads the capacitor voltage 90 degree

#### Series RC

- $C_{total} = \frac{1}{\left( \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \right)}$
- $X_{C_{total}} = X_{C_1} + X_{C_2} + X_{C_3}$

#### Parallel RC

- $X_{C} = \frac{1}{2\pi f C}$

### AC Fundamentals

#### FORMULA SUMMARY

1. For capacitive reactance $X_C$

2. Series RC

3. Capacitive Reactance

4. For capacitor the current $I_C$ leads the capacitor voltage 90 degree

5. Parallel RC

- $V_C = I_{total} \times X_C$
- $\text{Phase angle} = \tan \left( -\frac{X_C}{R} \right)$

- $Z_{total} = \sqrt{R^2 + X_C^2}$
- $I_{total} = \frac{V_{total}}{Z_{total}}$
- $V_R = I_{total} \times R$
- $I_{total} = \sqrt{I_R^2 + I_C^2}$
- $I_R = \frac{V_T}{R}$
- $I_C = \frac{V_T}{X_C}$
- $Z_{total} = \frac{V_T}{I_{total}}$
- $\text{Phase angle} = \tan \left( \frac{I_C}{I_R} \right)$
### AC Fundamentals

#### SUMMARY

| Ltotal = $1 / (1/L1 + 1/L2 + 1/L3)$ |
| For inductive Reactance $\text{XL}$ |
| $\text{XL}_{\text{Total}} = 1 / (1/\text{XL}1 + 1/\text{XL}2 + 1/\text{XL}3)$ |

#### Inductor Reactance

For inductor the voltage $\text{VL}$ leads the inductor current $\text{IL}$ 90 degree

| $\text{XL} = 2\pi f L$ |
| $\text{Z}_{\text{Total}} = \sqrt{R^2 + \text{XL}^2}$ |
| $\text{I}_{\text{Total}} = \text{V}_{\text{Total}} / \text{Z}_{\text{Total}}$ |
| $\text{VR} = \text{I}_{\text{Total}} \times R$ |
| $\text{VL} = \text{I}_{\text{Total}} \times \text{XL}$ |
| Phase angle = $\tan^{-1}(\text{XL} / R)$ |

#### Series RL

| $\text{L}_{\text{Total}} = \text{L}_1 + \text{L}_2 + \text{L}_3$ |
| $\text{Z}_{\text{Total}} = \sqrt{R^2 + \text{XL}^2}$ |
| $\text{I}_{\text{Total}} = \sqrt{\text{I}_R^2 + \text{I}_L^2}$ |
| $\text{IR} = \text{V} / R$ |
| $\text{IL} = \text{V} / \text{XL}$ |
| $\text{Z}_{\text{Total}} = \text{V} / \text{I}_{\text{Total}}$ |
| Phase angle = $\tan^{-1} (-\text{IL} / \text{IR})$ |

#### Parallel RL

| $\text{L}_{\text{Total}} = \text{L}_1 + \text{L}_2 + \text{L}_3$ |
| $\text{Z}_{\text{Total}} = \sqrt{\text{R}^2 + \text{XL}^2}$ |
| $\text{I}_{\text{Total}} = \sqrt{\text{I}_R^2 + \text{I}_L^2}$ |
| $\text{IR} = \text{V} / R$ |
| $\text{IL} = \text{V} / \text{XL}$ |
| $\text{Z}_{\text{Total}} = \text{V} / \text{I}_{\text{Total}}$ |
| Phase angle = $\tan^{-1} (-\text{IL} / \text{IR})$ |
11 Series RCL

**Net Reactance** $X = XC - XL$ or $XL - XC$

$XC > XL$ capacitive circuit

$XL > XC$ inductive circuit

**Resonant Frequency**

$$\frac{1}{(2\pi) \sqrt{LC}}$$

**Total Impedance at Resonance**

$$Z_T = r_i$$

**Total Current at Resonance**

$$I_T = \frac{V_{total}}{Z_T}$$

**Quality (Q) of the Coil**

$$Q = \frac{XL}{r_i}$$

12 Parallel RCL

**Net Reactance**

$$IX = IC - IL$$ or $$IL - IC$$

$IC > IL$ capacitive circuit

$IL > IC$ inductive circuit

**Total Impedance**

$$Z_T = \sqrt{R^2 + X^2}$$

**Total Current**

$$I_T = \sqrt{I^2 + IX^2}$$

13 RESONANCE

**Series Resonance**

- **Resonant frequency**
  $$\frac{1}{(2\pi) \sqrt{LC}}$$
  
  - Frequency in hertz
  - $L$ in henry
  - $C$ in farad

- **Total Impedance at Resonance**
  $$Z_T = r_i$$

- **Total Current at Resonance**
  $$I_T = \frac{V_T}{Z_T}$$

- **Quality (Q) of the Coil**
  $$Q = \frac{XL}{r_i}$$
at resonance $VL = IT \times XL$ and $VC = IT \times XC$

phase angle between $VT$ and $IT$ at resonance is 0 degree

Parallel Resonance

Resonant frequency is the same as Series resonance

$XL = 2\pi F_r L$ \hspace{1cm} $XC = 2\pi F_r C$

Total impedance $ZT = Q \times XL$

Total current $IT = VT / ZT$

$IL = VT / XL$ \hspace{1cm} $IC = VT / XC$

Band width of resonant circuit $BW = F_r / Q$

Low edged frequency $F_L = F_r - BW/2$

High edged frequency $F_H = F_r + BW/2$

14 POWERS

Real Power \hspace{1cm} $P = I^2 \times R$ \hspace{1cm} $P$ in watt \hspace{1cm} $I$ in ampere \hspace{1cm} and $R$ in ohm

Apparent power \hspace{1cm} $P = VT \times IT$ \hspace{1cm} the unit of apparent power is VA

Power factor \hspace{1cm} $PF = \text{Real power} / \text{Apparent power}$ \hspace{1cm} and $PF$ is 0 to 1

For Series circuit \hspace{1cm} $PF = \cos \theta_Z = R/Z$

For parallel circuit \hspace{1cm} $PF = \cos \theta_I = IR / IT$

15 COUPLING Capacitor \hspace{1cm} $C_C = XC / R$ ratio of 1/10 that means $XC = R/10$

16 Transformer

$VP = \text{primary voltage}$

$VS = \text{secondary voltage}$

$NP$ = number of turn in primary

$NS$ = number of turn in secondary

$VS / VP = NS / NP$

$VS / VP = IP / IS$

Reflected Impedance

$ZP = (NP / NS)^2 \times ZS$

or

$NP / NS = \sqrt{ZP / ZS}$

$ZP = \text{primary impedance}$

$ZS = \text{secondary impedance}$

17 COMPLEX NUMBERS

Rectangular form \hspace{1cm} $C = a + Jb$

$a =$ real number $=$ $b$

$J =$ imaginary $=$ square-root(-1)

Polar form \hspace{1cm} $C =$ square-root$(a^2 + b^2)$

angle $=$ tan-1$(b/a)$