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| **Complex Numbers** |
|  | Rectangular form**:** $A=A\_{R}+jA\_{I}$Polar form:  $\left|A\right|∠φ\_{A}$ Rectangular to polar $\left|A\right|=\sqrt{\left(A\_{R}\right)^{2}+\left(A\_{I}\right)^{2}}$  $φ\_{A}=tan^{-1}\left(\frac{A\_{I}}{A\_{R}}\right)$ Polar to rectangular $A\_{R}=\left|A\right|\cos(\left(φ\_{A}\right))$  $A\_{I}=\left|A\right|\sin(\left(φ\_{A}\right))$ |
| **Euler’s Law:** $e^{jθ}=\cos(\left(θ\right))+j\sin(\left(θ\right))$ |
| **Mathematics with complex number** |
| **Addition/Subtraction – Rectangular form** $A+B=\left(A\_{R}+B\_{R}\right)+j\left(A\_{I}+B\_{I}\right)$  $A-B=\left(A\_{R}-B\_{R}\right)+j\left(A\_{I}-B\_{I}\right)$Complex conjugate $A=A\_{R}+jA\_{I}$ $A^{\*}=A\_{R}-jA\_{I}$ | **Multiplication/Dvision – Rectangular form** $AB=\left|A\right|\left|B\right|∠\left(φ\_{A}+φ\_{B}\right)$  $\frac{A}{B}=\frac{\left|A\right|}{\left|B\right|}∠\left(φ\_{A}-φ\_{B}\right)$Complex conjugate $A=\left|A\right|∠φ\_{A}$ $A^{\*}=\left|A\right|∠-φ\_{A}$ |
| **AC Steady State signals** |
| **Time domain signals**$F\left(t\right)=A\_{o}cos⁡(ωt+θ)$Ao – amplitude ω – radial frequency, 2πf ϴ – phase  | **Phasor signals** $\tilde{F}=A\_{o}∠θ$ Ao – amplitude ϴ – phase |
| **(Rectangular form)** $F\left(t\right)=A\_{o}\cos(\left(ωt+θ\right))\leftrightarrow A\_{o}R\left\{e^{j\left(ωt+θ\right)}\right\}\leftrightarrow A\_{o}e^{jθ}\leftrightarrow A\_{o}∠θ$ **(Phasor form)** |
| **Impedances – Laplace domain (zero initial conditions)** |
| $$Z\_{R}=R$$ | $$Z\_{L}=sL$$ | $$Z\_{C}=\frac{1}{sC}$$ |
| **Impedances – AC steady state** |
| $$Z\_{R}=R$$$$Z\_{R}=R∠0°$$ | $$Z\_{L}=jωL$$$$Z\_{L}=ωL∠90°$$ | $$Z\_{C}=\frac{1}{jωC}$$$$Z\_{C}=\frac{1}{ωC}∠-90°$$ |
| ***Impedance, Z [Ω], properties have the same characteristics as resistance*** ***In series add,*** $Z\_{EQ}=Z\_{1}+Z\_{2}$ ***In parallel, inverse relationship,*** $Z\_{EQ}=\left(\frac{1}{Z\_{1}}+\frac{1}{Z\_{2}}\right)^{-1}=\frac{Z\_{1}Z\_{2}}{Z\_{1}+Z\_{2}}$ |
| ***Admittance, Y [mho], properties have characteristics that are the ‘inverse’ of impedance*** ***In parallel, add,*** $Y\_{EQ}=Y\_{1}+Y\_{2}$ ***In series, inverse relationship,*** $Y\_{EQ}=\left(\frac{1}{Y\_{1}}+\frac{1}{Y\_{2}}\right)^{-1}=\frac{Y\_{1}Y\_{2}}{Y\_{1}+Y\_{2}}$ |
| **AC Steady State Power** |
| $$S=P+jQ$$ S – Complex power P – Real power, [W] Q – Reactive power, [VAR]**|S|** –Apparent Power, [VA] | Using Ohm’s Law relationships for impedances (Z)If using VRMS2 version of equations also divide by |Z| (phasor form) \*cos or sin θ OR must use complex conjugate of Z (rectangular form) |
| Capacitive reactance is negative (Q < 0)Inductive reactance is positive (Q > 0)Power produced by the source(s) is equal to the sum of the power produced/stored for each impedance in the circuit | Power factor – a metric over how efficient power consumption/production appears to be0 < power factor < 1Power factor = $\frac{P}{\left|S\right|}=\cos(\left(φ\_{S}\right))$ |
| **Power Triangle** |
| **Ideal Transformers** |
| Np : number of windings on the primaryNs : number of windings on the secondary | Primary: source side of the transformerSecondary: load side of the transformerThe winding ratio, $N=\frac{Ns}{Np}$Voltage relationship, $Vs=NVp$Current relationship, $Is=\frac{Ip}{N}$ |
|  | Refer to secondary (voltage source):$Vo\_{eq}=NVo$$Zs\_{eq}=N^{2}Zs$Refer to secondary (current source):$Io\_{eq}=\frac{Io}{N}$$Zs\_{eq}=N^{2}Zs\_{eq}$Refer to primary:$ZL\_{eq}=\frac{ZL}{N^{2}}$ |
| **Mutual Inductance** |
|  | The Tee model for coupled inductors represents an equivalent circuit.M is the mutual inductance, the coupling between the two inductors. $M=k\sqrt{L\_{1}L\_{2}}$where k is the coupling coefficient 0 < k < 1 |
| **Student Requested Add-ons** |

 

