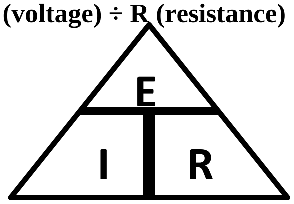
Extra Exam Quick Reference

Ohms Law Triangle

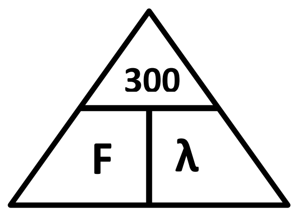
Current I (amperes) is equal to the Electro Motive Force E (volts) divided by Resistance R (ohms).

I (amperes) = E (voltage) ÷ R (resistance)



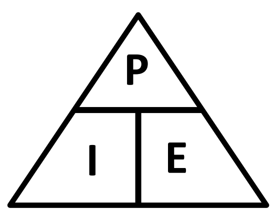
Wavelength (λ) Triangle

Wavelength (λ) in meters = 300 ÷ Frequency (in megahertz) Velocity = Velocity (V) = 300 (velocity of light in millions of meters per second) divided by Frequency in MHz



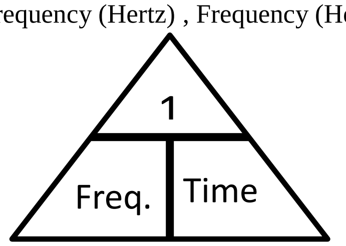
Power Triangle

Power= Current x the Voltage or Current = Power ÷Voltage or Voltage = Power ÷ Current



Frequency Time Triangle

Time (Seconds) = 1÷ Frequency (Hertz) , Frequency (Hertz) = 1÷ Time (seconds)



Peak vs RMS

Peak Voltage vs. RMS:

For a pure sine wave the equivalent RMS value is 0.707 times the peak value. Conversely the peak voltage can be calculated as 1.414 times the RMS Value.

Examples: The peak voltage at a standard 120V RMS AC line voltage outlet is 1.414 x 120V or approx. 170 volts peak. The peak to peak (maximum negative to maximum positive peaks) would be two times the peak voltage or approx. 340 V Peak to Peak.

Peak = RMS Voltage x 1.414 or Peak = 120 x 1.414 or Peak =169.7 Volts

PP = 2x Peak or PP = 2 x (120 x 1.414) o PP = 2 x 169.7 or PP = 339.4 Volts

An AC voltage that reads 65 volts on an RMS meter will have a peak to peak voltage of 184 Volts.

Peak to Peak voltage = 2 x RMS x 1.414 or PP= 2 x 65 x 1.414 or PP= 183.8 Volts

Modulation Index

The modulation index indicates by how much the modulated variable varies around its unmodulated level. It relates to variations in the carrier frequency:

Modulation Index = ΔFrequency /Frequency of modulation

For a 5 KHz deviation signal with a 3 KHz modulating frequency the modulation index would be:

Mod Index = 5,000 ÷ 3,000 or Mod index = 1.666

L and S bands

The terms L band and S bands with regard to satellite communications are the 23 centimeter and 13 centimeter bands

The 23 cm band would be ~ 1,300 MHz and the 13 CM Band would be ~2,300 MHz

L Band	**1 - 2 GHz**
S Band	**2-4 GHz**

Image frequency responses

What transmit frequency might generate an image response signal in a receiver tuned to 14.300 MHz and which uses a 455 kHz IF frequency?

The Local Oscillator signal would be 455 KHz higher than the receive frequency, or 13,755 Mhz. A signal 455 KHz above this LO Frequency would also produce a 455 KHz if output or 13.755MHz +455KHz or 15.210 MHz

Intermodulation products

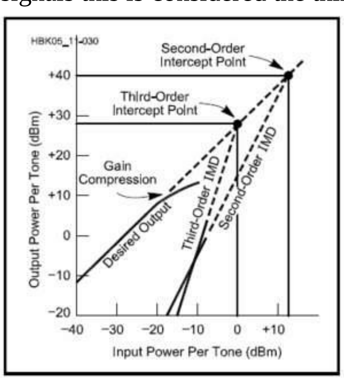
What transmitter frequencies would cause an intermodulation-product signal in a receiver tuned to 146.70 MHz when a nearby station transmits on 146.52 MHz?

The first intermodulation product is: $I_{mod} = 2F_1 - f_2$ or $146.70 = 2(146.52) - f_2$ or $146.70 - f_2$ or $146.7 - 293.04 = - f_2$ or $-146.34 = - f_2$ or $f_2 = 146.34$ MHz

The Second intermodulation product is: $I_{mod} = F_1 - 2f_2$
$146.70 = 146.52 - 2 f_2$ or $146.70 + 145.52 = 2 f_2$ or $293.22 = 2 f_2$ or $f_2 = 146.61$ MHz

Third order intercept point

What does a third-order intercept level (point) of 40 dBm mean with respect to receiver performance?
A pair of 40 dBm signals will theoretically generate a third-order intermodulation product with the same level as the two input signals . The pair of input signals as they are increased together will produce a third order products. The third order signal increases at faster rate (3:1) than when the two test signals are increased. When the third order signal rises to the level of the test signals this is considered the third order intercept point and is expressed in dBm.



Circuit Q

Calculating the Q of an RLC series resonant circuit calculated by taking the reactance of either the inductance or capacitance and dividing it by the resistance

$$Q = X_L / R \quad \text{or} \quad Q = X_C / R$$

Resonant Frequency of a Series RLC circuit

The resonant frequency of a series RLC circuit with R = 22 ohms, L = 50 microhenrys and C = 40 picofarads is 3.56 MHz

F(resonance in MHz)=1,000 / (2π√(L x C)) where Inductance is in micro-henries and capacitance is in picofarads: F(resonance)=1,000 / (2π√(L x C)) or 1,000 / (6.28 √(50 x 40)) or 3.56 MHz

Resonant Frequency of a parallel RLC circuit

What is the resonant frequency of a parallel RLC circuit if R is 33 ohms, L is 50 microhenrys and C is 10 picofarads? **7.12 MHz**

$F_{(resonance)}$=1,000 / (2π√(L x C)) = 1,000 / (6.28'√ (50 x 10)) = 7.121 MHz

Time Constant

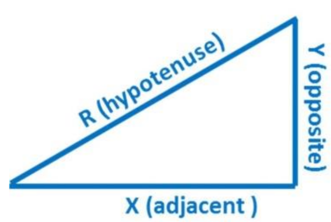
Time Constant (TC) = R (megohms) x C (microfarads) for a 2 megohm resistor and a one microfarad capacitor the time constant would be two seconds.

The charge after 1 time constant will be 63.2% of the applied voltage, for example 100 volts, or 63.2 volts after 2 minutes

Time Constants	***Charge % of applied voltage***	***Discharge % of starting voltage***
1	*63.2%*	*36.8%*
2	*86.5%*	*13.5 %*
3	*95.0%*	*5%*
4	*98.2%*	*1.8%*
5	*99.3%*	*.7%*

Trigonometry

For a number of problems associated with electronics involving series circuits of resistance and reactance in the Extra class Exam you will need a basic understanding of trigonometry. The problems center on a right triangle (that is a triangle that has one angle that is 90° and the sum of the remaining two angles is equal to 90°). Using trigonometric functions if we know two sides, or an angle (other than the 90°angle) and one side of the triangle we can calculate the remaining angles and dimensions.



The sides of the triangle are given names from the rectangular coordinate system with the horizontal side called X (also called the Adjacent side) and the vertical side is called Y (also called the opposite side) and the side connecting the X and Y sides is called the Hypotenuse called R in this example
If two of the three sides are known the third side can be found using the following equation:

$$\text{Hypotenuse} = \sqrt{(X^2+Y^2)}$$

There are three trigonometric functions that can be used to calculate the angle Θ between X and R and between Y and R. They are Sine, Cosine and Tangent to solve for the angle between the X side and the R side.

Sine of Θ = Y / R
Cosine of Θ = X / R
Tangent of Θ = Y / X

Capacitive Reactance

The AC resistance of a capacitor is called capacitive reactance (Xc) and is calculated using the formula:

$$X_C = 1/(2\pi \times F \times C) \text{ with C in µF and F in MHz}$$

Example

Find the capacitive reactance of a 1 µf capacitor at 200 Hz

$X_C = 1/(2\pi \times F \times C)$ or $X_C = 1/(6.28 \times .0002 \times 1)$ or $X_C = 796\ \Omega$

Inductive Reactance

The AC resistance of an Inductor is called Inductive reactance (X_L) and is calculated using the formula: $X_L = 2\pi \times F \times L$ with L in µH and F in MHz

Example:

Find the inductive reactance of a 1 µH inductor at 100 MHz

$X_L = 2\pi \times F \times L$ or $X_L = 6.28 \times 100 \times 1$ or $X_L = 628\ \Omega$

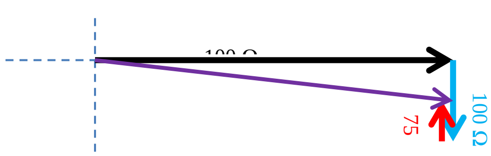
Susceptance (B)

BL (Inductive Susceptance) = 1÷ (2πFL)
BC (Capacitive Susceptance) = 2πFC

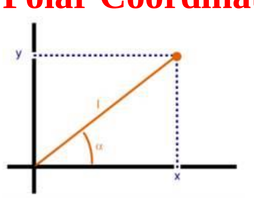
RLC Phase angle

The phase angle between the voltage across and the current through a series RLC circuit if XC is 100 ohms, R is 100 ohms, and XL is 75 ohms is 14 degrees with the voltage lagging the current

Tangent of Θ = Y ÷ X or Tangent of Θ = -100 +75÷ 100 or arc Tangent of Θ = -0 .25 or Θ = -14.04°



Polar Coordinate Impedance



Power Factor

What is the power factor of an R-L circuit having a 60 degree phase angle between the voltage and the current? **0.5**

Power factor is the cosine of the phase angle. The cosine of 60° is 0.5

The power factor of an R-L circuit having a 45 degree phase angle between the voltage and the current is the cosine if the angle or the Cosine of 45° = .707

Deviation Ratio

Deviation ratio is the ratio of the maximum carrier frequency deviation to the highest audio modulating frequency

deviation ratio = max deviation ÷ max modulation frequency

Required Bandwidth

The necessary bandwidth of a 170-hertz shift, 300-baud ASCII transmission is 0.5 kHz

The bandwidth of the signal depends on the frequency shift used and the speed the data is transmitted.

The formula is: BW = (K x Shift) + B Where: BW is the bandwidth; K is a constant that depends on allowable distortion. 1.2 is practical for amateur communications, Shift is the frequency shift in Hz and B is the symbol rate in baud.

BW = (1.2 x 170 Hz) + 300 or 204 = 300 or 504Hz or 0.504 KHz

Antenna Efficiency:

Antenna efficiency is Radiation Resistance / Total Resistance) x 100 per cent

Effective Radiated Power

The effective radiated power relative to a dipole of a repeater station with 150 watts transmitter power output, 2 dB feed line loss, 2.2 dB duplexer loss, and 7 dBd antenna gain is 286 watts.

***ERP* = 150 watts- (-2dB -2.2 dB +7dB) or 150 watts + 2.8 dB**

2.8 dB = 10log (P/ 150 watts) or ((2.8÷10) ^(0.28) x (P/150)) or P=1.90 x 150 or P=285.8 Watts

Electrical vs physical wavelength in Coaxial Cable

The approximate physical length of a solid polyethylene dielectric coaxial transmission line that is electrically one-quarter wavelength long at 14.1 MHz is 3.5 meters

¼ wavelength = (0.25 (300÷14.1))(0.66) or .(25 x 21.28)(0.66) or 5.319 x 0.66 or 3.51 meters

Toroid Transformer impedance ratios

How many turns will be required to produce a 5-microhenry inductor using a powdered-iron toroidal core that has an inductance index (A L) value of 40 micro-henrys /100 turns? 35 turns

N(turns) = turns √(desired L ÷ L for turns) or

100√(5 ÷ 40) or 100 x .353 or 35