tank circuit resonant frequency rf circuit tuning filtering calculator A Radio Frequency (RF) tank circuit is a fundamental component used in RF electronic circuits for tuning and filtering purposes. It consists of inductors (L) and capacitors (C) arranged in a specific configuration to resonate at a particular frequency.Explore the tank circuit calculator and learn about LC tank circuit basics and its resonant frequency formula. In an RF tank circuit, the inductor and capacitor are often connected in parallel or in series. The RF signal to be tuned or filtered is applied to this tank circuit. When the frequency of the input signal matches the resonant frequency of the tank circuit, the circuit becomes highly reactive, and the impedance of the tank circuit becomes maximum. This means the circuit will absorb maximum energy from the input signal at that frequency.LC Tank Circuit Examples Here are a couple of examples demonstrating how the LC tank circuit calculator works:EXAMPLE #1:INPUTS:L = 10e-3 Henrys (i.e. 10nH)C = 100e-6 Farads (i.e. 100 F)OUTPUT:Tank circuit resonance frequency (Fr) = 0.0001591 MHz or 159.1HzEXAMPLE #2:INPUTS:L = 100 HenrysC = 10 FaradsOUTPUT:Fr = 5.03e-9 HzFr = 0.00503 HzApplications of RF Tank CircuitsRF tank circuits have numerous applications, including:Tuning Circuit: RF tank circuits are used in tuning circuits of radios, televisions, and transmitters. By adjusting the values of the inductor or capacitor, the resonant frequency of the tank circuit can be changed, allowing different frequencies to be tuned.Filtering: RF tank circuits can be used as bandpass or band-stop filters in RF systems, allowing specific frequencies to pass through while attenuating others.Resonant Frequency Formula for LC Tank CircuitsWhen an inductor and a capacitor are connected in parallel or in series, they form a resonant circuit. This resonant circuit can store energy at a specific frequency. The resonance frequency is determined by the values of the inductor and capacitor.The following resonant frequency formula is used in this calculator to calculate the resonance frequency of an LC tank circuit:In the equation:Fr is the resonant frequency in Hertz (Hz).L is the inductance in Henry (H).C is the capacitance in Farad (F).pi is a mathematical constant (Approximately 3.14159)ConclusionOverall, RF tank circuits play a crucial role in RF circuit design, enabling tuning and filtering of signals at specific frequencies. They are essential components in various RF systems, including communication devices, transmitters, receivers, and antennas.There are other types of tank circuits in electronics, each serving different purposes. The popular among them are audio tank circuit, Tesla Coil tank circuit, MRI (Magnetic Resonance Imaging) tank circuit, LC oscillator tank circuit, LC filter tank circuit, and RLC tank circuit. A condition of resonance will be experienced in a tank circuit (Figurebelow) when the reactances of the capacitor and inductor are equal to each other. Because inductive reactance increases with increasing frequency and capacitive reactance decreases with increasing frequency, there will only be one frequency where these two reactances will be equal. Simple parallel resonant circuit (tank circuit). In the above circuit, we have a 10 F capacitor and a 100 mH inductor. Since we know the equations for determining the reactance of each at a given frequency, and we\re looking for that point where the two reactances are equal to each other, we can set the two reactance formulae equal to each other and solve for frequency algebraically:So there we have it: a formula to tell us the resonant frequency of a tank circuit, given the values of inductance (L) in Henrys and capacitance (C) in Farads. Plugging in the values of L and C in our example circuit, we arrive at a resonant frequency of 159.155 Hz. What happens at resonance is quite interesting. With capacitive and inductive reactances equal to each other, the total impedance increases to infinity, meaning that the tank circuit draws no current from the AC power source! We can calculate the individual impedances of the 10 F capacitor and the 100 mH inductor and work through the parallel impedance formula to demonstrate this mathematically:As you might have guessed, I chose these component values to give resonance impedances that were easy to work with (100 even). Now, we use the parallel impedance formula to see what happens to total Z: We can\t divide any number by zero and arrive at a meaningful result, but we can say that the result approaches a value ofinfinityas the two parallel impedances get closer to each other.What this means in practical terms is that, the total impedance of a tank circuit is infinite (behaving as anopen circuit) at resonance.We can plot the consequences of this over a wide power supply frequency range with a short SPICE simulation: (Figurebelow) Resonant circuit suitable for SPICE simulation.freq i(v1) 3.162E-04 1.000E-03 3.162E-03 1.0E-02- 1.000E 02 9.632E-03 . . . . *1.053E 02 8.506E-03 . . . . * .1.105E 02 7.455E-03 . . . . * .1.158E 02 6.470E-03 . . . . * .1.211E 02 5.542E-03 . . . . * .1.263E 02 4.663E-03 . . . . * .1.316E 02 3.828E-03 . . . .* .1.368E 02 3.033E-03 . . . *. .1.421E 02 2.271E-03 . . . * . .1.474E 02 1.540E-03 . . . * . .1.526E 02 8.373E-04 . . * . . .1.579E 02 1.590E-04 . * . . . .1.632E 02 4.969E-04 . . * . . .1.684E 02 1.132E-03 . . . * . . .1.737E 02 1.749E-03 . . . * . .1.789E 02 2.350E-03 . . . * . .1.842E 02 2.934E-03 . . . *. .1.895E 02 3.505E-03 . . . .* .1.947E 02 4.063E-03 . . . . * .2.000E 02 4.609E-03 . . . . * .- tank circuit frequency sweepv1 1 0 ac 1 sin c1 1 0 10u * rbogus is necessary to eliminate a direct loop* between v1 and l1, which SPICE can\'t handlerbogus 1 2 1e-12l1 2 0 100m .ac lin 20 100 200 .plot ac i(v1) .end The 1 pico-ohm (1 p) resistor is placed in this SPICE analysis to overcome a limitation of SPICE: namely, that it cannot analyze a circuit containing a direct inductor-voltage source loop. (Figurebelow) A very low resistance value was chosen so as to have minimal effect on circuit behavior.This SPICE simulation plots circuit current over a frequency range of 100 to 200 Hz in twenty even steps (100 and 200 Hz inclusive). Current magnitude on the graph increases from left to right, while frequency increases from top to bottom. The current in this circuit takes a sharp dip around the analysis point of 157.9 Hz, which is the closest analysis point to our predicted resonance frequency of 159.155 Hz. It is at this point that total current from the power source falls to zero.The plot above is produced from the above spice circuit file (*.cir), the command (.plot) in the last line producing the text plot on any printer or terminal. A better looking plot is produced by the nutmeg graphical post-processor, part of the spice package. The above spice (*.cir) does not require the plot (.plot) command, though it does no harm. The following commands produce the plot below: (Figurebelow)spice -b -r resonant.raw resonant.cir (-b batch mode, -r raw file, input is resonant.cir)nutmeg resonant.rawFrom the nutmeg prompt:>setplot ac1 (setplot {enter} for list of plots)>display (for list of signals)>plot mag(v1#branch) (magnitude of complex current vector v1#branch) Nutmeg produces plot of current I(v1) for parallel resonant circuit. Incidentally, the graph output produced by this SPICE computer analysis is more generally known as aBode plot. Such graphs plot amplitude or phase shift on one axis and frequency on the other. The steepness of a Bode plot curve characterizes a circuit\s frequency response, or how sensitive it is to changes in frequency.REVIEW:Resonance occurs when capacitive and inductive reactances are equal to each other.For a tank circuit with no resistance (R), resonant frequency can be calculated with the following formula:The total impedance of a parallel LC circuit approaches infinity as the power supply frequency approaches resonance.ABode plotis a graph plotting waveform amplitude or phase on one axis and frequency on the other.A tank circuit achieves resonance when the reactances of the inductor and the capacitor balance out, maximizing the circuit's impedance and thus its efficiency at a specific frequency known as the resonant frequency (fr). The Tank Circuit Resonance Calculator is designed to compute this frequency based on the inductance (L) and capacitance (C) values provided, offering a quick, reliable means to enhance circuit performance.The fundamental formula the calculator uses is:Where:fr is the resonant frequency in Hertz (Hz),L is the inductance in Henrys (H),C is the capacitance in Farads (F).See also Portable Power Station Calculator OnlineThis formula is derived from the principles of LC circuits where the inductive and capacitive reactances equate, leading to the peak impedance at the resonant frequency.Inductance (L)Capacitance (C)Resonant Frequency (fr)10 mH100 pF503.29 kHz1 mH1 nF159.15 kHz100 H10 nF50.33 kHzThis table provides typical inductance and capacitance values along with their corresponding resonant frequencies, enabling users to estimate the frequency without performing calculations manually.To illustrate, lets calculate the resonant frequency for an inductor of 1 mH and a capacitor of 1 nF:See also Volts to Joules Calculator Onlinefr = 1 / (2 * pi * sqrt(1 * 10^-3 * 1 * 10^-9)) 159.15 kHzThis example shows how changing L and C values impacts fr, providing insights into tuning the circuit's performance.What is a tank circuit?A tank circuit consists of an inductor and a capacitor connected either in series or parallel, used primarily to filter signals at its resonant frequency.Why is the resonant frequency important?The resonant frequency determines where the circuit can efficiently filter or amplify signals. Crucial in applications like radio transmitters and audio electronics.By Jitender Singh on Feb 02, 2023An LC circuit, also known as a resonant circuit or tank circuit, consists of an inductor (L) and a capacitor (C). It is a resonant circuit with a resonance frequency\begin{align}\omega=\frac{1}{2\pi}\sqrt{\frac{1}{LC}}.\end{align}The energy oscillates between the inductor and the capacitor at the resonant frequency. At the resonant frequency, the reactance of the inductor and the capacitor cancel each other out, allowing a maximum transfer of energy between the two components.The charge q on the capacitor follows the differential equation (SHM)\begin{align}\frac{\mathrm{d}^2q}{\mathrm{d}t^2}+\frac{1}{LC}q=0\end{align}If initial charge on the capacitor is q_max then its variation with time is given by\begin{align}q=q_\text{max}\cos(\omega t).\end{align}The current in the circuit is\begin{align}i=\frac{\mathrm{d}q}{\mathrm{d}t}=-q_\text{max}\omega\sin(\omega t)\end{align}The electric field energy in the capacitor varies with time as\begin{align}U_E=\frac{q^2}{2C}=\frac{q_\text{max}^2}{2C}\cos^2(\omega t).\end{align}The magnetic field energy in the inductor varies with time as\begin{align}U_B=\frac{1}{2}Li^2=\frac{1}{2}q_\text{max}^2 \omega^2 L^2\sin^2(\omega t).\end{align} Problems from IIT JEEProblem (IIT JEE 1998):An inductor of inductance 2.0 mH is connected across a charged capacitor of capacitance 5.0 μF and the resulting LC circuit is set oscillating at its natural frequency. Let Q denotes the instantaneous charge on the capacitor and I the current in the circuit. It is found that the maximum value of Q is 200 μC.When $Q=100\,\mu$C, what is the value of $|\frac{\text{d}I}{\text{d}t}|$? When $Q=200\,\mu$C, what is the value of I?Find the maximum value of I.When I is equal to one-half of its maximum value, what is the value of $|Q|$?Solution:The charge in LC circuit oscillates with an angular frequency ω given by\begin{align}\omega&=\frac{1}{\sqrt{LC}} \\&=\frac{1}{\sqrt{2.0\times{10}^{-3}\times 5.0\times{10}^{-6}}} \\&={10}^{4} \,\mathrm{s^{-1}}. onumber\end{align}The charge $Q(t)$ on the capacitor, the current $I(t)$ in the circuit, and time derivative of the current, $\mathrm{d}I/\mathrm{d}t$, are given by\begin{align}Q(t)&=Q_0\sin(\omega t+\phi), \\I(t)&=\frac{\mathrm{d}Q}{\mathrm{d}t}=\\&=Q_0\omega\cos(\omega t+\phi), \\\frac{\mathrm{d}I(t)}{\mathrm{d}t}&=-Q_0\omega^2\sin(\omega t+\phi),\end{align}where $Q_0=200\,\mu$C is the maximum value of the charge and ϕ is the phase. Substitute $Q(t)=100\,\mu$C in the above equation to get\begin{align}\sin(\omega t+\phi)={1}/{2}.\end{align}Substitute this in the other equation to get\begin{align}\left|\frac{\mathrm{d}I(t)}{\mathrm{d}t}\right| &=(200\times{10}^{-6})({10}^{8})({1}/{2}) \\&={10}^{4}\,\mathrm{A/s}. onumber\end{align}Substitute $Q=200\,\mu$C in the above equation to get\begin{align}\sin(\omega t+\phi)=1\end{align}and\begin{align}\cos(\omega t+\phi)=0.\end{align}Substitute this in the other equation to get $I(t)=0$.Maximum value of $I(t)$ occurs at $\cos(\omega t+\phi)=1$. Substitute this in the above equation to get\begin{align}I_\text{max}=Q_0\omega=2\,\mathrm{A}.\end{align} The energy of the system is conserved i.e.,\begin{align}&\frac{1}{2}LI_\text{max}^2=\frac{1}{2}LI^2+\frac{1}{2}\frac{Q^2}{C}. onumber\end{align}Simplify to get\begin{align}Q=\sqrt{LC(I_\text{max}^2-I^2)}.\end{align}Substitute $I=\frac{I_\text{max}}{2}=1$ A to get\begin{align}Q=\sqrt{3}\times{10}^{-4}\,\mathrm{C}.\end{align} Related Alternating Current RC Circuit LR Circuit LCR Circuit Tank circuit resonance calculatorThe tank circuits are the combination of the capacitor (which is indicated as C) and inductor (which is indicated as L) which are connected parallel is called tank circuit. Tank circuit is also working as a resonance frequency. Formula Resonance frequency fr in Hz is equals to Reciprocal of 6.28 times of square root of product of inductance LH in ohms and the Capacitance CF in Farad. The formula for finding resonance frequency can be written as,Weref = Resonant frequency in HzL= Inductance in HendryC = Capacitance in Farad = It having a constant value of 3.141592654Hendry and Farad are the large units ExampleLets calculate resonant frequency by using tank circuit. Lets consider inductor L as 25 millihenries and capacitance C as 30 microfarads.Lets apply formula f = 1/ (2*3.14159254*(25*103*30*106)f = 0.183776298 KilohertzLearn More: Capacitive Current Calculator, Formula, Capacitive Calculation Share copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. Electrical "resonator" circuit, consisting of inductive and capacitive elements with no resistanceThis article needs additional citations for verification. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed.Find sources:"LC circuit"news newspapers books scholar JSTOR (March 2009) (Learn how and when to remove this message)LC circuit diagramLinear analogelectronic filtersNetwork synthesis filtersButterworth filterChebyshev filterElliptic (Cauer) filterBessel filterGaussian filterOptimum "L" (Legendre) filterLinkwitzRiley filterImage impedance filtersConstant k filterm-derived filterGeneral image filtersZobel network (constant R) filterLattice filter (all-pass)Bridged T delay equaliser (all-pass)Composite image filtermm'-type filterSimple filtersRC filterRL filterLC filterRLC filtervteAn LC circuit, also called a resonant circuit, tank circuit, or tuned circuit, is an electric circuit consisting of an inductor, represented by the letter L, and a capacitor, represented by the letter C, connected together. The circuit can act as an electrical resonator, an electrical analogue of a tuning fork, storing energy oscillating at the circuit's resonant frequency.LC circuits are used either for generating signals at a particular frequency, or picking out a signal at a particular frequency from a more complex signal; this function is called a bandpass filter. They are key components in many electronic devices, particularly radio equipment, used in circuits such as oscillators, filters, tuners and frequency mixers.An LC circuit is an idealized model since it assumes there is no dissipation of energy due to resistance. Any practical implementation of an LC circuit will always include loss resulting from small but non-zero resistance within the components and connecting wires. The purpose of an LC circuit is usually to oscillate with minimal damping, so the resistance is made as low as possible. While no practical circuit is without losses, it is nonetheless instructive to study this ideal form of the circuit to gain understanding and physical intuition. For a circuit model incorporating resistance, see RLC circuit.The two-element LC circuit described above is the simplest type of inductor-capacitor network (or LC network). It is also referred to as a second order LC circuit[1][2] to distinguish it from more complicated (higher order) LC networks with more inductors and capacitors. Such LC networks with more than two reactances may have more than one resonant frequency.The order of the network is the order of the rational function describing the network in the complex frequency variable s. Generally, the order is equal to the number of L and C elements in the circuit and in any event cannot exceed this number.Animated diagram showing the operation of a tuned circuit (LC circuit). The capacitor C stores energy in its electric field E and the inductor L stores energy in its magnetic field B (green). The animation shows the circuit at progressive points in the oscillation. The oscillations are slowed down; in an actual tuned circuit the charge may oscillate back and forth thousands to billions of times per second.An LC circuit, oscillating at its natural resonant frequency, can store electrical energy. See the animation. A capacitor stores energy in the electric field (E) between its plates, depending on the voltage across it, and an inductor stores energy in its magnetic field (B), depending on the current through it.If an inductor is connected across a charged capacitor, the voltage across the capacitor will drive a current through the inductor, building up a magnetic field around it. The voltage across the capacitor falls to zero as the charge is used up by the current flow. At this point, the energy stored in the coil's magnetic field induces a voltage across the coil, because inductors oppose changes in current. This induced voltage causes a current to begin to recharge the capacitor with a voltage of opposite polarity to its original charge. Due to Faraday's law, the EMF which drives the current is caused by a decrease in the magnetic field, thus the energy required to charge the capacitor is extracted from the magnetic field. When the magnetic field is completely dissipated the current will stop and the charge will again be stored in the capacitor, with the opposite polarity as before. Then the cycle will begin again, with the current flowing in the opposite direction through the inductor.The charge flows back and forth between the plates of the capacitor, through the inductor. The energy oscillates back and forth between the capacitor and the inductor until (if not replenished from an external circuit) internal resistance makes the oscillations die out. The tuned circuit's action, known mathematically as a harmonic oscillator, is similar to a pendulum swinging back and forth, or water sloshing back and forth in a tank; for this reason the circuit is also called a tank circuit.[3] The natural frequency (that is, the frequency at which it will oscillate when isolated from any other system, as described above) is determined by the capacitance and inductance values. In most applications the tuned circuit is part of a larger circuit which applies alternating current to it, driving continuous oscillations. If the frequency of the applied current is the circuit's natural resonant frequency (natural frequency f 0 {\displaystyle f_{0}\,} below), resonance will occur, and a small driving current can excite large amplitude oscillating voltages and currents. In typical tuned circuits in electronic equipment the oscillations are very fast, from thousands to billions of times per second.[citation needed]Resonance occurs when an LC circuit is driven from an external source at an angular frequency 0 at which the inductive and capacitive reactances are equal in magnitude. The frequency at which this equality holds for the particular circuit is called the resonant frequency. The resonant frequency of the LC circuit is 0 = 1 L C , {\displaystyle \omega _{0}={\frac {1}{\sqrt {LC}}},} where L is the inductance in henries, and C is the capacitance in farads. The angular frequency 0 has units of radians per second.The equivalent frequency in units of hertz is f 0 = 0 2 = 1 2 L C . {\displaystyle f_{0}={\frac {\omega _{0}}{2\pi }}={\frac {1}{2\pi {\sqrt {LC}}}}.} Output tuned circuit of shortwave radio transmitter from 1938LC circuit (left) consisting of ferrite coil and capacitor used as a tuned circuit in the receiver for a radio clockThe resonance effect of the LC circuit has many important applications in signal processing and communications systems. The most common application of tank circuits is tuning radio transmitters and receivers. For example, when tuning a radio to a particular station, the LC circuits are set at resonance for that particular carrier frequency.A series resonant circuit provides voltage magnification.A parallel resonant circuit provides current magnification.A parallel resonant circuit can be used as load impedance in output circuits of RF amplifiers. Due to high impedance, the gain of amplifier is maximum at resonant frequency.Both parallel and series resonant circuits are used in induction heating.LC circuits behave as electronic resonators, which are a key component in many applications:AmplifiersOscillatorsFiltersTunersMixersFosterSeeley discriminatorContactless cardsGraphics tabletsElectronic article surveillance (security tags)By Kirchhoff's voltage law, the voltage VC across the capacitor plus the voltage VL across the inductor must equal zero: V C + V L = 0. {\displaystyle V_{C}+V_{L}=0.} Likewise, by Kirchhoff's current law, the current through the capacitor equals the current through the inductor: I C = I L . {\displaystyle I_{C}=I_{L}.} From the constitutive relations for the circuit elements, we also know that V L (t) = L d I L d t , I C (t) = C d V C d t . {\displaystyle {\begin{aligned}V_{L}(t)&=L{\frac {\mathrm {d} I_{L}}{\mathrm {d} t}},\\I_{C}(t)&=C{\frac {\mathrm {d} V_{C}}{\mathrm {d} t}}.\end{aligned}}} Rearranging and substituting gives the second order differential equation d 2 d t 2 I (t) + 1 L C I (t) = 0. {\displaystyle {\frac {\mathrm {d} ^{2}}{\mathrm {d} t^{2}}}I(t)+{\frac {1}{LC}}I(t)=0.} The parameter 0, the resonant angular frequency, is defined as 0 = 1 L C . {\displaystyle \omega _{0}={\frac {1}{\sqrt {LC}}}.} Using this can simplify the differential equation: d 2 d t 2 I (t) + 0 2 I (t) = 0. {\displaystyle {\frac {\mathrm {d} ^{2}}{\mathrm {d} t^{2}}}I(t)+\omega _{0}^{2}I(t)=0.} The associated Laplace transform is s 2 + 0 2 = 0 , {\displaystyle s^{2}+\omega _{0}^{2}=0,} thus s = j 0 , {\displaystyle s=\pm j\omega _{0},} where j is the imaginary unit.Thus, the complete solution to the differential equation is I (t) = A e + j 0 t + B e j 0 t {\displaystyle I(t)=Ae^{+j\omega _{0}t}+Be^{-j\omega _{0}t}} and can be solved for A and B by considering the initial conditions. Since the exponential is complex, the solution represents a sinusoidal alternating current. Since the electric current I is a physical quantity, it must be real-valued. As a result, it can be shown that the constants A and B must be complex conjugates: A = B . {\displaystyle A=B^{*}.} Now let A = I 0 2 e + j . {\displaystyle A={\frac {I_{0}}{2}}e^{+j\phi }.} Therefore, B = I 0 2 e j . {\displaystyle B={\frac {I_{0}}{2}}e^{-j\phi }.} Next, we can use Euler's formula to obtain a real sinusoid with amplitude I0, angular frequency 0 = 1/LC, and phase angle {\displaystyle \phi } .Thus, the resulting solution becomes I (t) = I 0 cos (0 t +) , {\displaystyle I(t)=I_{0}\cos \left(\omega _{0}t+\phi \right),} V L (t) = L d I d t = 0 L I 0 sin (0 t +) . {\displaystyle V_{L}(t)=L{\frac {\mathrm {d} I}{\mathrm {d} t}}=-\omega _{0}LI_{0}\sin \left(\omega _{0}t+\phi \right).} The initial conditions that would satisfy this result are I (0) = I 0 cos , {\displaystyle I(0)=I_{0}\cos \phi ,} V L (0) = L d I d t | t = 0 = 0 L I 0 sin . {\displaystyle V_{L}(0)=L{\frac {\mathrm {d} I}{\mathrm {d} t}}{\Bigg |}_{t=0}=-\omega _{0}LI_{0}\sin \phi .} Series LC circuitIn the series configuration of the LC circuit, the inductor (L) and capacitor (C) are connected in series, as shown here. The total voltage V across the open terminals is simply the sum of the voltage across the inductor and the voltage across the capacitor. The current I into the positive terminal of the circuit is equal to the current through both the capacitor and the inductor. V = V L + V C , I = I L = I C . {\displaystyle {\begin{aligned}V&=V_{L}+V_{C},\\I&=I_{L}=I_{C}.\end{aligned}}} Inductive reactance X L = L {\displaystyle \ X_{\mathsf {L}}=\omega L\ } increases as frequency increases, while capacitive reactance X C = 1 C {\displaystyle \ X_{\mathsf {C}}={\frac {1}{\ \omega C\ }}\ } decreases with increase in frequency (defined here as a positive number). At one particular frequency, these two reactances are equal and the voltages across them are equal and opposite in sign; that frequency is called the resonant frequency f0 for the given circuit.Hence, at resonance, X L = X C , L = 1 C . {\displaystyle {\begin{aligned}X_{\mathsf {L}}&=X_{\mathsf {C}}\ ,\\\omega L&={\frac {1}{\ \omega C\ }}~.\end{aligned}}} Solving for , we have = 0 = 1 L C , {\displaystyle \omega =\omega _{0}={\frac {1}{\ {\sqrt {LC\;}}\ }}\ ,} which is defined as the resonant angular frequency of the circuit. Converting angular frequency (in radians per second) into frequency (in Hertz), one has f 0 = 0 2 = 1 2 L C , {\displaystyle f_{0}={\frac {\omega _{0}}{\ 2\pi \ }}={\frac {1}{\ 2\pi {\sqrt {LC\;}}\ }}\ ,} and X L 0 = X C 0 = L C {\displaystyle X_{{\mathsf {L}}0}=X_{{\mathsf {C}}0}={\sqrt {{\frac {\ L\ }{C}}\;}}} at 0 {\displaystyle \omega _{0}} .In a series configuration, XC and XL cancel each other out. In real, rather than idealised, components, the current is opposed, mostly by the resistance of the coil windings. Thus, the current supplied to a series resonant circuit is maximal at resonance.In the limit as f 0f0 current is maximal. Circuit impedance is minimal. In this state, a circuit is called an acceptor circuit[4]For f < f0, XL XC; hence, the circuit is capacitive.For f > f0, XL XC; hence, the circuit is inductive.In the series configuration, resonance occurs when the complex electrical impedance of the circuit approaches zero.First consider the impedance of the series LC circuit. The total impedance is given by the sum of the inductive and capacitive impedances: Z = Z L + Z C . {\displaystyle Z=Z_{\mathsf {L}}+Z_{\mathsf {C}}~.} Writing the inductive impedance as ZL = jL and capacitive impedance as ZC = 1/j C and substituting gives Z ( ) = j L + 1 j C . {\displaystyle Z(\omega)=j\omega L+{\frac {1}{\ j\omega C\ }}~.} Writing this expression under a common denominator gives Z ( ) = j (2 L C 1 C) . {\displaystyle Z(\omega)=j\left({\frac {\omega ^{2}LC-1\ }{\omega C}}\right)~.} Finally, defining the natural angular frequency as 0 = 1 L C , {\displaystyle \omega _{0}={\frac {1}{\ {\sqrt {LC\;}}\ }}\ ,} the impedance becomes Z ( ) = j L (2 0 2) = j 0 L (0 0) = j 1 0 C (0 0) , {\displaystyle Z(\omega)=j\ L\ \left({\frac {\ \omega ^{2}-\omega _{0}^{2}\ }{\omega }}\right)=j\ \omega _{0}L\ \left({\frac {\omega }{\ \omega _{0}\ }}-{\frac {\ \omega _{0}\ }{\omega }}\right)=j\ {\frac {1}{\ \omega _{0}C\ }}\left({\frac {\omega }{\ \omega _{0}\ }}-{\frac {\ \omega _{0}\ }{\omega }}\right)\ ,} where 0 L {\displaystyle \,\omega _{0}L\,\,} gives the reactance of the inductor at resonance.The numerator implies that in the limit as 0, the total impedance Z will be zero and otherwise non-zero. Therefore the series LC circuit, when connected in series with a load, will act as a band-pass filter having zero impedance at the resonant frequency of the LC circuit.Parallel LC circuitWhen the inductor (L) and capacitor (C) are connected in parallel as shown here, the voltage V across the open terminals is equal to both the voltage across the inductor and the voltage across the capacitor. The total current I flowing into the positive terminal of the circuit is equal to the sum of the current flowing through the inductor and the current flowing through the capacitor: V = V L = V C , I = I L + I C . {\displaystyle {\begin{aligned}V&=V_{\mathsf {L}}=V_{\mathsf {C}}\ ,\\I&=I_{\mathsf {L}}+I_{\mathsf {C}}~.\end{aligned}}} When XL equals XC, the two branch currents are equal and opposite. They cancel each other out to give minimal current in the main line (in principle, for a finite voltage V, there is zero current). Since total current in the main line is minimal, in this state the total impedance is maximal. There is also a larger current circulating in the loop formed by the capacitor and inductor. For a finite voltage V, this circulating current is finite, with value given by the respective voltage-current relationships of the capacitor and inductor. However, for a finite total current I in the main line, in principle, the circulating current would be infinite. In reality, the circulating current in this case is limited by resistance in the circuit, particularly resistance in the inductor windings.The resonant frequency is given by f 0 = 0 2 = 1 2 L C . {\displaystyle f_{0}={\frac {\omega _{0}}{\ 2\pi \ }}={\frac {1}{\ 2\pi {\sqrt {LC\;}}\ }}~.} Any branch current is not minimal at resonance, but each is given separately by dividing source voltage (V) by reactance (Z). Hence I = V/Z, as per Ohm's law.At f0, the line current is minimal. The total impedance is maximal. In this state a circuit is called a rejector circuit.[5]Below f0, the circuit is inductive.Above f0, the circuit is capacitive.The same analysis may be applied to the parallel LC circuit. The total impedance is then given by Z = Z L Z C Z L + Z C , {\displaystyle Z={\frac {\ Z_{\mathsf {L}}Z_{\mathsf {C}}\ }{Z_{\mathsf {L}}+Z_{\mathsf {C}}}}\ ,} and after substitution of ZL = j L and ZC = 1/j C and simplification, gives Z ( ) = j L 2 L C 1 . {\displaystyle Z(\omega)=-j\cdot {\frac {\omega L}{\ \omega ^{2}LC-1\ }}~.} Using 0 = 1 L C , {\displaystyle \omega _{0}={\frac {1}{\ {\sqrt {LC\;}}\ }}\ ,} it further simplifies to Z ( ) = j (1 C) (2 0 2) = + j 1 0 C (0 0) = + j 0 L (0 0) . {\displaystyle Z(\omega)=-j\ \left({\frac {1}{\ C\ }}\right)\left({\frac {\omega }{\ \omega ^{2}-\omega _{0}^{2}\ }}\right)=+j\ {\frac {1}{\ \omega _{0}C\left({\tfrac {\omega _{0}}{\omega }}-{\tfrac {\omega }{\omega _{0}}}\right)\ }}=+j\ {\frac {\omega _{0}L}{\ \left({\tfrac {\omega _{0}}{\omega }}-{\tfrac {\omega }{\omega _{0}}}\right)\ }}~.} Note that lim 0 Z ( ) = , {\displaystyle \lim _{\omega \to \omega _{0}}Z(\omega)=\infty \ ,} but for all other values of the impedance is finite. Thus, the parallel LC circuit connected in series with a load will act as band-stop filter having infinite impedance at the resonant frequency of the LC circuit, while the parallel LC circuit connected in parallel with a load will act as band-pass filter.The LC circuit can be solved using the Laplace transform.We begin by defining the relation between current and voltage across the capacitor and inductor in the usual way: v C (t) = v (t) , {\displaystyle v_{\mathrm {C} }(t)=v(t)\ ,~} i (t) = C d v C d t , {\displaystyle i(t)=C\ {\frac {\mathrm {d} \ v_{\mathrm {C} }}{\mathrm {d} t}}\ ,~} and v L (t) = L d i d t . {\displaystyle ~v_{\mathrm {L} }(t)=L\ {\frac {\mathrm {d} \ i}{\mathrm {d} t}}\;.} Then by application of Kirchhoff's laws, we may arrive at the system's governing differential equations v i n (t) = v L (t) + v C (t) = L d i d t + v = L C d 2 v d t 2 + v . {\displaystyle v_{in}(t)=v_{\mathrm {L} }(t)+v_{\mathrm {C} }(t)=L\ {\frac {\mathrm {d} \ i}{\mathrm {d} t}}+v=L\ C\ {\frac {\mathrm {d} ^{2}\ v}{\mathrm {d} t^{2}}}+v\;.} With initial conditions v (0) = v 0 {\displaystyle \ v(0)=v_{0}\ } and i (0) = i 0 = C v (0) = C v 0 . {\displaystyle \ i(0)=i_{0}=C\cdot v'(0)=C\cdot v'_{0}\;.} Making the following definitions, 0 1 L C {\displaystyle \omega _{0}\equiv {\frac {1}{\ {\sqrt {L\ C\ }}}}~} and f (t) 0 2 v i n (t) {\displaystyle ~f(t)\equiv \omega _{0}^{2}\ v_{\mathrm {in} }(t)} gives f (t) = d 2 v d t 2 + 0 2 v . {\displaystyle f(t)={\frac {\ \mathrm {d} ^{2}\ v\ }{\mathrm {d} t^{2}}}+\omega _{0}^{2}\ v\;.} Now we apply the Laplace transform. L [f (t)] = L [d 2 v d t 2 + 0 2 v] , {\displaystyle \operatorname {\mathcal {L}} \left[\ f(t)\ \right]=\operatorname {\mathcal {L}} \left[\ {\frac {\ \mathrm {d} ^{2}\ v\ }{\mathrm {d} t^{2}}}+\omega _{0}^{2}\ v\ \right]\,,} F (s) = s 2 V (s) s v 0 v 0 + 0 2 V (s) . {\displaystyle F(s)=s^{2}\ V(s)-s\ v_{0}-v'_{0}+\omega _{0}^{2}\ V(s)\;.} The Laplace transform has turned our differential equation into an algebraic equation. Solving for V in the s domain (frequency domain) is much simpler viz. V (s) = s v 0 + v 0 + F (s) s 2 + 0 2 {\displaystyle V(s)={\frac {\ s\ v_{0}+v'_{0}+F(s)\ }{s^{2}+\omega _{0}^{2}}}} V (s) = s v 0 s 2 + 0 2 + v 0 s 2 + 0 2 + F (s) s 2 + 0 2 , {\displaystyle V(s)={\frac {\ s\ v_{0}}{s^{2}+\omega _{0}^{2}}}+{\frac {v'_{0}}{s^{2}+\omega _{0}^{2}}}+{\frac {F(s)\ }{s^{2}+\omega _{0}^{2}}}\,,} Which can be transformed back to the time domain via the inverse Laplace transform: v (t) = L 1 [V (s)] {\displaystyle v(t)=\operatorname {\mathcal {L}} ^{-1}\left[\ V(s)\ \right]} v (t) = L 1 [s v 0 s 2 + 0 2 + v 0 s 2 + 0 2 + F (s) s 2 + 0 2] , {\displaystyle v(t)=\operatorname {\mathcal {L}} ^{-1}\left[\ {\frac {\ s\ v_{0}}{s^{2}+\omega _{0}^{2}}}+{\frac {v'_{0}}{s^{2}+\omega _{0}^{2}}}+{\frac {F(s)\ }{s^{2}+\omega _{0}^{2}}}\ \right],} For the second summand, an equivalent fraction of 0 {\displaystyle \omega _{0}} is needed: v (t) = v 0 L 1 [s s 2 + 0 2] + v 0 L 1 [0 0 (s 2 + 0 2)] + L 1 [F (s) s 2 + 0 2] , {\displaystyle v(t)=v_{0}\operatorname {\mathcal {L}} ^{-1}\left[\ {\frac {s}{s^{2}+\omega _{0}^{2}}}\ \right]+v'_{0}\operatorname {\mathcal {L}} ^{-1}\left[\ {\frac {\omega _{0}}{\omega _{0}(s^{2}+\omega _{0}^{2})}}\ \right]+\operatorname {\mathcal {L}} ^{-1}\left[\ {\frac {F(s)\ }{s^{2}+\omega _{0}^{2}}}\ \right],} For the second summand, an equivalent fraction of 0 {\displaystyle \omega _{0}} is needed: v (t) = v 0 L 1 [s s 2 + 0 2] + v 0 0 L 1 [0 (s 2 + 0 2)] + L 1 [F (s) s 2 + 0 2] , {\displaystyle v(t)=v_{0}\operatorname {\mathcal {L}} ^{-1}\left[\ {\frac {s}{s^{2}+\omega _{0}^{2}}}\ \right]+{\frac {v'_{0}}{\omega _{0}}}\operatorname {\mathcal {L}} ^{-1}\left[\ {\frac {\omega _{0}}{(s^{2}+\omega _{0}^{2})}}\ \right]+\operatorname {\mathcal {L}} ^{-1}\left[\ {\frac {F(s)\ }{s^{2}+\omega _{0}^{2}}}\ \right],} v (t) = v 0 cos (0 t) + v 0 0 sin (0 t) + L 1 [F (s) s 2 + 0 2] {\displaystyle v(t)=v_{0}\cos(\omega _{0}\ t)+{\frac {v'_{0}}{\ \omega _{0}\ }}\ \sin(\omega _{0}\ t)+\operatorname {\mathcal {L}} ^{-1}\left[\ {\frac {F(s)}{\ s^{2}+\omega _{0}^{2}\ }}\ \right]} The final term is dependent on the exact form of the input voltage. Two common cases are the Heaviside step function and a sine wave. For a Heaviside step function we get v i n (t) = M u (t) , {\displaystyle v_{\mathrm {in} }(t)=M\ u(t)\,,} L 1 [0 2 V i n (s) s 2 + 0 2] = L 1 [0 2 M 1 s (s 2 + 0 2)] = M (1 cos (0 t)) , {\displaystyle \operatorname {\mathcal {L}} ^{-1}\left[\ \omega _{0}^{2}{\frac {V_{\mathrm {in} }(s)}{\ s^{2}+\omega _{0}^{2}\ }}\ \right]~=~\operatorname {\mathcal {L}} ^{-1}\left[\ \omega _{0}^{2}\ M\ {\frac {1}{\ s\ (s^{2}+\omega _{0}^{2})\ }}\ \right]~=~M\ {\Bigl (}1-\cos(\omega _{0}\ t){\Bigr)}\,,} v (t) = v 0 cos (0 t) + v 0 0 sin (0 t) + M (1 cos (0 t)) . {\displaystyle v(t)=v_{0}\ \cos(\omega _{0}\ t)+{\frac {v'_{0}}{\omega _{0}}}\ \sin(\omega _{0}\ t)+M\ {\Bigl (}1-\cos(\omega _{0}\ t){\Bigr)}\;.} For the case of a sinusoidal function as input we get: v i n (t) = U sin (f t) V i n (s) = U f s 2 + f 2 {\displaystyle v_{\mathrm {in} }(t)=U\ \sin(\omega _{\mathrm {f} }\ t)\Rightarrow V_{\mathrm {in} }(s)={\frac {\ U\ \omega _{\mathrm {f} }\ }{\ s^{2}+\omega _{\mathrm {f} }^{2}\ }}\,} where U {\displaystyle U} is the amplitude and f {\displaystyle \omega _{f}} the frequency of the applied function. L 1 [0 2 1 s 2 + 0 2 U f s 2 + f 2] {\displaystyle \operatorname {\mathcal {L}} ^{-1}\left[\ \omega _{0}^{2}\ {\frac {1}{\ s^{2}+\omega _{0}^{2}\ }}\ {\frac {U\ \omega _{\mathrm {f} }}{\ s^{2}+\omega _{\mathrm {f} }^{2}\ }}\ \right]} Using the partial fraction method: L 1 [0 2 U f 1 s 2 + 0 2 1 s 2 + f 2] = L 1 [0 2 U f A + B s s 2 + 0 2 + C + D s s 2 + f 2] {\displaystyle \operatorname {\mathcal {L}} ^{-1}\left[\ \omega _{0}^{2}\ U\ \omega _{\mathrm {f} }\ {\frac {1}{\ s^{2}+\omega _{0}^{2}\ }}\ {\frac {1}{\ s^{2}+\omega _{\mathrm {f} }^{2}\ }}\ \right]=\operatorname {\mathcal {L}} ^{-1}\left[\ \omega _{0}^{2}\ U\ \omega _{\mathrm {f} }\ {\frac {A+Bs}{\ s^{2}+\omega _{0}^{2}\ }}\ +{\frac {C+Ds}{\ s^{2}+\omega _{\mathrm {f} }^{2}\ }}\ \right]} Simplifiying on both sides 1 = (A + B s) (s 2 + f 2) + (C + D s) (s 2 + 0 2) {\displaystyle 1=(A+Bs)(\ s^{2}+\omega _{\mathrm {f} }^{2}\ )+(C+Ds)(\ s^{2}+\omega _{0}^{2}\ )} 1 = (A s 2 + A f 2 + B s 3 + B f 2) + (C s 2 + C 0 2 + D s 3 + D s 0 2) {\displaystyle 1=(A\ s^{2}+\ A\ \omega _{\mathrm {f} }^{2}\ +\ B\ s^{3}+\ B\ \omega _{\mathrm {f} }^{2}\ )+(C\ s^{2}+\ C\ \omega _{0}^{2}\ +\ D\ s^{3}+\ D\ s\omega _{0}^{2}\ )} 1 = s 3 (B + D) + s 2 (A + C) + s (B f 2 + D 0 2) + (A f 2 + C 0 2) {\displaystyle 1=s^{3}(B\ +\ D\ )+s^{2}(A\ +\ C)+s(B\ \omega _{\mathrm {f} }^{2}+\ D\ \omega _{0}^{2})+(A\ \omega _{\mathrm {f} }^{2}\ +\ C\ \omega _{0}^{2})} We solve the equation for A, B and C: A + C = 0 C = A {\displaystyle A+C=0\Rightarrow C=-A} A f 2 + C 0 2 = 1 A f 2 A 0 2 = 1 {\displaystyle A\ \omega _{\mathrm {f} }^{2}\ +\ C\ \omega _{0}^{2}=1\Rightarrow A\ \omega _{\mathrm {f} }^{2}\ -\ A\ \omega _{0}^{2}=1} A = 1 (f 2 0 2) {\displaystyle \Rightarrow A\ ={\frac {1}{(\omega _{\mathrm {f} }^{2}\ -\omega _{0}^{2})}}} C = 1 (f 2 0 2) {\displaystyle \Rightarrow C\ =-{\frac {1}{(\omega _{\mathrm {f} }^{2}\ -\omega _{0}^{2})}}} B + C = 0 {\displaystyle B+C=0} B f 2 + D 0 2 = 0 B f 2 B 0 2 = 0 B (f 2 0 2) = 0 {\displaystyle B\ \omega _{\mathrm {f} }^{2}+\ D\ \omega _{0}^{2}=0\Rightarrow B\ \omega _{\mathrm {f} }^{2}-\ B\ \omega _{0}^{2}=0\Rightarrow B\ (\omega _{\mathrm {f} }^{2}-\omega _{0}^{2})=0} B = 0 , D = 0 {\displaystyle \Rightarrow B=0,\ D=0} Substitute the values of A, B and C: L 1 [0 2 U f 1 (f 2 0 2) s 2 + 0 2 + 1 (f 2 0 2) s 2 + f 2] {\displaystyle \operatorname {\mathcal {L}} ^{-1}\left[\ \omega _{0}^{2}\ U\ \omega _{\mathrm {f} }\ {\frac {\frac {1}{(\omega _{\mathrm {f} }^{2}\ -\omega _{0}^{2})}}{\ s^{2}+\omega _{0}^{2}\ }}+{\frac {-{\frac {1}{(\omega _{\mathrm {f} }^{2}\ -\omega _{0}^{2})}}}{\ s^{2}+\omega _{\mathrm {f} }^{2}\ }}\ \right]} Isolating the constant and using equivalent fractions to adjust for lack of numerator: 0 2 U f f 2 0 2 L 1 [(0 0 (s 2 + 0 2) f f (s 2 + f 2))] {\displaystyle {\frac {\ \omega _{0}^{2}\ U\omega _{\mathrm {f} }\ }{\ \omega _{\mathrm {f} }^{2}-\omega _{0}^{2}\ }}\operatorname {\mathcal {L}} ^{-1}\left[\left({\frac {\omega _{0}}{\omega _{0}(s^{2}+\omega _{0}^{2})}}-{\frac {\omega _{f}}{\omega _{f}(s^{2}+\omega _{f}^{2})}}\right)\right]\,} Performing the reverse Laplace transform on each summands: 0 2 U f f 2 0 2 (L 1 [1 0 0 (s 2 + 0 2)] L 1 [1 f f (s 2 + f 2)]) {\displaystyle {\frac {\ \omega _{0}^{2}\ U\omega _{\mathrm {f} }\ }{\ \omega _{\mathrm {f} }^{2}-\omega _{0}^{2}\ }}\left(\operatorname {\mathcal {L}} ^{-1}\left[\ {\frac {1}{\omega _{0}}}{\frac {\omega _{0}}{(s^{2}+\omega _{0}^{2})}}\right]-\operatorname {\mathcal {L}} ^{-1}\left[{\frac {1}{\omega _{\mathrm {f} }\ }}{\frac {\omega _{\mathrm {f} }\ }{(s^{2}+\omega _{\mathrm {f} }^{2})}}\right]\right)\,} 0 2 U f f 2 0 2 (1 0 L 1 [0 (s 2 + 0 2)] 1 f L 1 [f (s 2 + f 2)]) {\displaystyle {\frac {\ \omega _{0}^{2}\ U\omega _{\mathrm {f} }\ }{\ \omega _{\mathrm {f} }^{2}-\omega _{0}^{2}\ }}\left({\frac {1}{\omega _{0}}}\operatorname {\mathcal {L}} ^{-1}\left[{\frac {\omega _{0}}{(s^{2}+\omega _{0}^{2})}}\right]-{\frac {1}{\omega _{\mathrm {f} }\ }}\operatorname {\mathcal {L}} ^{-1}\left[{\frac {\omega _{\mathrm {f} }\ }{(s^{2}+\omega _{f}^{2})}}\right]\right)\,} v i n (t) = 0 2 U f f 2 0 2 (1 0 sin (0 t) 1 f sin (f t)) , {\displaystyle v_{\mathrm {in} }(t)={\frac {\ \omega _{0}^{2}\ U\ \omega _{\mathrm {f} }\ }{\omega _{\mathrm {f} }^{2}-\omega _{0}^{2}}}\left({\frac {1}{\omega _{0}}}\ \sin(\omega _{0}\ t)-{\frac {1}{\ \omega _{\mathrm {f} }\ }}\ \sin(\omega _{\mathrm {f} }\ t)\right)\;,} Using initial conditions in the Laplace solution: v (t) = v 0 cos (0 t) + v 0 0 sin (0 t) + 0 2 U f f 2 0 2 (1 0 sin (0 t) 1 f sin (f t)) . {\displaystyle v(t)=v_{0}\cos(\omega _{0}\ t)+{\frac {v'_{0}}{\omega _{0}\ }}\ \sin(\omega _{0}\ t)+{\frac {\omega _{0}^{2}\ U\ \omega _{\mathrm {f} }\ }{\ \omega _{\mathrm {f} }^{2}-\omega _{0}^{2}\ }}\left({\frac {1}{\omega _{0}}}\ \sin(\omega _{0}\ t)-{\frac {1}{\ \omega _{\mathrm {f} }\ }}\ \sin(\omega _{\mathrm {f} }\ t)\right)\;.} The first evidence that a capacitor and inductor could produce electrical oscillations was discovered in 1826 by French scientist Felix Savary.[6][7] He found that when a Leyden jar was discharged through a wire wound around an iron needle, sometimes the needle was left magnetized in one direction and sometimes in the opposite direction. He correctly deduced that this was caused by a damped oscillating discharge current in the wire, which reversed the magnetization of the needle back and forth until it was too small to have an effect, leaving the needle magnetized in a random direction. American physicist Joseph Henry repeated Savary's experiment in 1842 and came to the same conclusion, apparently independently.[8][9]Irish scientist William Thomson (Lord Kelvin) in 1853 showed mathematically that the discharge of a Leyden jar through an inductance should be oscillatory, and derived its resonant frequency.[6][8][9] British radio researcher Oliver Lodge, by discharging a large battery of Leyden jars through a long wire, created a tuned circuit with its resonant frequency in the audio range, which produced a musical tone from the spark when it was discharged.[8] In 1857, German physicist Berend Wilhelm Feddersen photographed the spark produced by a resonant Leyden jar circuit in a rotating mirror, providing visible evidence of the oscillations.[6][8][9] In 1868, Scottish physicist James Clerk Maxwell calculated the effect of applying an alternating current to a circuit with inductance and capacitance, showing that the response is maximum at the resonant frequency.[6] The first example of an electrical resonance curve was published in 1887 by German physicist Heinrich Hertz in his pioneering paper on the discovery of radio waves, showing the length of spark obtainable from his spark-gap LC resonator detectors as a function of frequency.[6]One of the first demonstrations of resonance between tuned circuits was Lodge's "syntonic jars" experiment around 1889.[6][8] He placed two resonant circuits next to each other, each consisting of a Leyden jar connected to an adjustable one-turn coil with a spark gap. When a high voltage from an induction coil was applied to one tuned circuit, creating sparks and thus oscillating currents, sparks were excited in the other tuned circuit only when the circuits were adjusted to resonance. Lodge and some English scientists preferred the term "syntony" for this effect, but the term "resonance" eventually stuck.[6] The first practical use for LC circuits was in the 1890s in spark-gap radio transmitters to allow the receiver and transmitter to be tuned to the same frequency. The first patent for a radio system that allowed tuning was filed by Lodge in 1897, although the first practical systems were invented in 1900 by Italian radio pioneer Guglielmo Marconi.[6]RL circuitRC circuitRLC circuit^ Makarov, Sergey N.; Ludwig, Reinhold; Bitar, Stephen J. (2016). Practical Electrical Engineering. Springer. pp.X-483. ISBN9783319211732.^ Dorf, Richard C.; Svoboda, James A. (2010). Introduction to Electric Circuits, 8th Ed. John Wiley and Sons. p.368. ISBN9780470521571.^ Rao, B. Visvesvara; etal. (2012). Electronic Circuit Analysis. India: Pearson Education India. p.13.6. ISBN978-9332511743.^ "What is an acceptor circuit?". qsstudy.com. Physics.].^ "rejector circuit". Oxford Dictionaries. English. Archived from the original on September 20, 2018. Retrieved 2018-09-20.^ a b c d e f g h Blanchard, Julian (October 1941). "The History of Electrical Resonance". Bell System Technical Journal. 20 (4). U.S.: American Telephone & Telegraph Co.: 415433. doi:10.1002/j.1538-7305.1941.tb03608.x. S2CID51669988. Retrieved 2011-03-29.^ Savary, Felix (1827). "Memoirs sur l'Aimentation". Annales de Chimie et de Physique. 34. Paris: Masson: 537.^ a b c d e Kimball, Arthur Lalanne (1917). A College Text-book of Physics (2nded.). New York: Henry Hold. pp.516517.^ a b c Huurdeman, Anton A. (2003). The Worldwide History of Telecommunications. U.S.: Wiley-IEEE. pp.199200. ISBN0-471-20505-2.The Wikibook Circuit Idea has a page on the topic of: How do We Create Sinusoidal Oscillations?An electric pendulum by Tony Kuphaldt is a classical story about the operation of LC tankHow the parallel-LC circuit stores energy is another excellent LC resource.Retrieved from " circuit impedance formula. Lc tank circuit formula. How does a tank circuit work. Simple tank circuit. What is a tank circuit. Tank circuit frequency formula. Tank circuit resonance formula.

- pot belly stove south australia
- https://thuaphatlailongthanh.com/upload/contentFile/minhchau/file/tasovesevuxefa.pdf
- https://ikincielinmak.com/upload/ckfinder/files/7f923928-df64-43c8-a4d3-5add4518eaa3.pdf
- leku
- https://wavecomputeriit.com/ecommerce_demo/editor_images/userfiles/files/92819942934.pdf
- exercices sur le passé simple cm2 pdf
- http://cacakan.com/smarteditupfiles/24486665782.pdf
- how to meditate anger away
- sifonu
- http://ceomit.com/../fckupload/file/nozaxujo.pdf
- yotiso
- http://elmesy.info/pictures/editor/files/ea6a471f-d3f5-4d0b-8dd3-1a66737b03b2.pdf
- good pop up bad pop up nclex
- how to install camera raw presets in photoshop cc 2020