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How to determine resonant frequency

It is easy to get an object to vibrate at its resonant frequencies, hard at other frequencies. A child's playground swing is an example of a pendulum, a resonant system with only one resonant frequency. With a tiny push on the swing each time it comes back to you, you can continue to build up the amplitude of swing. If you try to force it to swing at twice that frequency, you will find it very difficult, and might even lose teeth in the process! Swinging a child in a playground swing is an easy job because you are helped by its natural frequency.But can you swing it at some other frequency? 1) What is the resonant frequency for an LC circuit with a .039 microfarad capacitor and a 1.5 Henry inductor? First click on what you are solving and the units you will need. Click "FREQUENCY", "Microfarads" and "Henrys". Then enter the numbers, click calculate and your answer is 658.02 Hertz. 2) You want the resonant frequency of an LC circuit to be 1,000 Hertz. If you have an inductor of 300 millihenrys, what value capacitor will you need? First click on what you are solving and the units you will need. Click "CAPACITANCE", "Hertz" and "Millihenrys", then enter 1,000 Hertz and 300 millihenrys and your answer will be .08434 microfarads, 84.434 nanofarads and 84,434 picofarads. 3) An LC circuit with a resonant frequency of 1.25 megahertz and a capacitance of 8 picofarads has what value of inductance? First click on what you are solving which is "INDUCTANCE", then select the units of "megahertz" and "picofarads". Then input the numbers, click calculate and your answer is 2.0264e+3 microhenrys or 2.0264 millihenrys or .0020264 henrys. Return To Home Page Copyright © 1999 - In this Quartz Resonators series video, we answer the question “What is Resonant Frequency?” Resonant frequency is the oscillation of a system at its natural or unforced resonance. Resonance occurs when a system is able to store and easily transfer energy between different storage modes, such as Kinetic energy or Potential energy as you would find with a simple pendulum. Most systems have one resonant frequency and multiple harmonic frequencies that get progressively lower in amplitude as they move away from the center. In the case of a quartz resonators, the Resonant Frequency is the desired frequency of oscillation that you want to achieve. There are two methods of using Resonant Frequencies to derive a clock. Crystals operating at or below 50 MHz are referred to as resonating at their fundamental or natural frequency. Shown in the graph here in red, when producing clocks that need to generate frequencies above 50 MHz you are taking advantage of harmonic frequencies. Harmonics are multiples of the fundamental frequency. Shown in the graph as 2nd, 3rd, 4th and 5th harmonic. As an example, a third harmonic would be three times the original frequency. In this case, the fundamental frequency of 110 hz x 3 = 330 hz. You can isolate and amplify the harmonics to give you a higher cleaner frequency than you would if you multiplied the original frequency. This opens up the available frequency spectrum to quartz based resonators. Watch the above video to learn more about Resonant Frequency then click on the button below to start searching for the exact part you need! Tendency to oscillate at certain frequencies This article is about resonance in physics. For other uses, see Resonance (disambiguation). "Resonate" redirects here. For other uses, see Resonate (disambiguation). "Resonant" redirects here. For the phonological term, see Sonorant. This article has multiple issues. Please help improve it or discuss these issues on the talk page. (Learn how and when to remove these template messages) This article's lead section may not adequately summarize its contents. To comply with Wikipedia's lead section guidelines, please consider modifying the lead to provide an accessible overview of the article's key points in such a way that it can stand on its own as a concise version of the article. (January 2021) This article is written like a research paper or scientific journal that may use overly technical terms or may not be written like an encyclopedic article. Please help improve it by rewriting it in an encyclopedic style. (January 2021) (Learn how and when to remove this template message) This 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: "Resonance" – news · newspapers · books · scholar · JSTOR (January 2021) (Learn how and when to remove this template message)... (Learn how and when to remove this template message) Increase of amplitude as damping decreases and frequency approaches resonant frequency of a driven damped simple harmonic oscillator.[1][2] Resonance describes the phenomenon of increased amplitude that occurs when the frequency of a periodically applied force (or a Fourier component of it) is equal or close to a natural frequency of the system on which it acts. When an oscillating force is applied at a resonant frequency of a dynamic system, the system will oscillate at a higher amplitude than when the same force is applied at other, non-resonant frequencies.[3] Frequencies at which the response amplitude is a relative maximum are also known as resonant frequencies or resonance frequencies of the system.[3] Small periodic forces that are near a resonant frequency of the system have the ability to produce large amplitude oscillations in the system due to the storage of vibrational energy. Resonance phenomena occur with all types of vibrations or waves: there is mechanical resonance, acoustic resonance, electromagnetic resonance, nuclear magnetic resonance (NMR), electron spin resonance (ESR) and resonance of quantum wave functions. Resonant systems can be used to generate vibrations of a specific frequency (e.g., musical instruments), or pick out specific frequencies from a complex vibration containing many frequencies (e.g., filters). The term resonance (from Latin resonantia, 'echo', from resonare, 'resound') originated from the field of acoustics, particularly the sympathetic resonance observed in musical instruments, e.g., when one string starts to vibrate and produce sound after a different one is struck. Overview Resonance occurs when a system is able to store and easily transfer energy between two or more different storage modes (such as kinetic energy and potential energy in the case of a simple pendulum). However, there are some losses from cycle to cycle, called damping. When damping is small, the resonant frequency is approximately equal to the natural frequency of the system, which is a frequency of unforced vibrations. Some systems have multiple, distinct, resonant frequencies. Examples Pushing a person in a swing is a common example of resonance. The loaded swing, a pendulum, has a natural frequency of oscillation, its resonant frequency, and resists being pushed at a faster or slower rate. A familiar example is a playground swing, which acts as a pendulum. Pushing a person in a swing in time with the natural interval of the swing (its resonant frequency) makes the swing go higher and higher (maximum amplitude), while attempts to push the swing at a faster or slower tempo produce smaller arcs. This is because the energy the swing absorbs is maximized when the pushes match the swing's natural oscillations. Resonance occurs widely in nature, and is exploited in many devices. It is the mechanism by which virtually all sinusoidal waves and vibrations are generated. Many sounds we hear, such as when hard objects of metal, glass, or wood are struck, are caused by brief resonant vibrations in the object. Light and other short wavelength electromagnetic radiation is produced by resonance on an atomic scale, such as electrons in atoms. Other examples of resonance: Timekeeping mechanisms of modern clocks and watches, e.g., the balance wheel in a mechanical watch and the quartz crystal in a quartz watch Tidal resonance of the Bay of Fundy Acoustic resonances of musical instruments and the human vocal tract Shattering of a crystal wineglass when exposed to a musical tone of the right pitch (its resonant frequency) Friction idiophones, such as making a glass object (glass, bottle, vase) vibrate by rubbing around its rim with a fingertip Electrical resonance of tuned circuits in radios and TVs that allow radio frequencies to be selectively received Creation of coherent light by optical resonance in a laser cavity Orbital resonance as exemplified by some moons of the solar system's gas giants Material resonances in atomic scale are the basis of several spectroscopic techniques that are used in condensed matter physics Electron spin resonance Mössbauer effect Nuclear magnetic resonance Linear systems Resonance manifests itself in many linear and nonlinear systems as oscillations around an equilibrium point. When the system is driven by a sinusoidal external input, a measured output of the system may oscillate in response. The ratio of the amplitude of the output's steady-state oscillations to the input's oscillations is called the gain, and the gain can be a function of the frequency of the sinusoidal external input. Peaks in the gain at certain frequencies correspond to resonances, where the amplitude of the measured output's oscillations are disproportionately large. Since many linear and nonlinear systems that oscillate are modeled as harmonic oscillators near their equilibria, this section begins with a derivation of the resonant frequency for a driven, damped harmonic oscillator. The section then uses an RLC circuit to illustrate connections between resonance and a system's transfer function, frequency response, poles, and zeroes. Building off the RLC circuit example, the section then generalizes these relationships for higher-order linear systems with multiple inputs and outputs. The driven, damped harmonic oscillator Main article: Harmonic oscillator § Driven harmonic oscillators Consider a damped mass on a spring driven by a sinusoidal, externally applied force. Newton's second law takes the form m d 2 x d t 2 = F 0 sin ⁡ (ω t) − k x − c d x d t , {\displaystyle m{\frac {\mathrm {d} ^{2}x}{\mathrm {d} t^{2}}}=F_{0}\sin(\omega t)-kx-c{\frac {\mathrm {d} x}{\mathrm {d} t}},} (1) where m is the mass, x is the displacement of the mass from the equilibrium point, F_0 is the driving amplitude, ω is the driving angular frequency, k is the spring constant, and c is the viscous damping coefficient. This can be rewritten in the form d 2 x d t 2 + 2 ζ ω 0 d x d t + ω 0 2 x = F 0 m sin ⁡ (ω t) , {\displaystyle {\frac {\mathrm {d} ^{2}x}{\mathrm {d} t^{2}}}+2\zeta \omega _{0}{\frac {\mathrm {d} x}{\mathrm {d} t}}+\omega _{0}^{2}x={\frac {F_{0}}{m}}\sin(\omega t),} (2) where ω 0 = k m {\displaystyle \omega _{0}={\sqrt {\frac {k}{m}}}} is called the undamped angular frequency of the oscillator or the natural frequency, ζ = c 2 m k {\displaystyle \zeta ={\frac {c}{2{\sqrt {mk}}}}} is called the damping ratio. Many sources also refer to ω_0 as the resonant frequency. However, as shown below, when analyzing oscillations of the displacement x(t), the resonant frequency is close to but not the same as ω_0. In general the resonant frequency is close to but not necessarily the same as the natural frequency.[4] The RLC circuit example in the next section gives examples of different resonant frequencies for the same system. The general solution of Equation (2) is the sum of a transient solution that depends on initial conditions and a steady state solution that is independent of initial conditions and depends only on the driving amplitude F_0, driving frequency ω, undamped angular frequency ω_0, and the damping ratio ζ. The transient solution decays in a relatively short amount of time, so to study resonance it is sufficient to consider the steady state solution. It is possible to write the steady-state solution for x(t) as a function proportional to the driving force with an induced phase change φ, x (t) = F 0 m (2 ω ω 0 ζ) 2 + (ω 0 2 − ω 2) 2 sin ⁡ (ω t + φ) , {\displaystyle x(t)={\frac {F_{0}}{m{\sqrt {\left(2\omega \omega _{0}\zeta \right)^{2}+(\omega _{0}^{2}-\omega ^{2})^{2}}}}}\sin(\omega t+\varphi),} (3) where φ = arctan ⁡ (2 ω ω 0 ζ ω 2 − ω 0 2) + n π . {\displaystyle \varphi =\arctan \left({\frac {2\omega \omega _{0}\zeta }{\omega ^{2}-\omega _{0}^{2}}}\right)+n\pi .} The phase value is usually taken to be between −180° and 0 so it represents a phase lag for both positive and negative values of the arctan argument. Steady-state variation of amplitude with relative frequency ω / ω 0 {\displaystyle \omega /\omega _{0}} and damping ζ {\displaystyle \zeta } of a driven simple harmonic oscillator Resonance occurs when, at certain driving frequencies, the steady-state amplitude of x(t) is large compared to its amplitude at other driving frequencies. For the mass on a spring, resonance corresponds physically to the mass's oscillations having large displacements from the spring's equilibrium position at certain driving frequencies. Looking at the amplitude of x(t) as a function of the driving frequency ω, the amplitude is maximal at the driving frequency ω r = ω 0 1 − 2 ζ 2 . {\displaystyle \omega _{r}=\omega _{0}{\sqrt {1-2\zeta ^{2}}}.} ω_r is the resonant frequency for this system. Again, note that the resonant frequency does not equal the undamped angular frequency ω_0 of the oscillator. They are proportional, and if the damping ratio goes to zero they are the same, but for non-zero damping they are not the same frequency. As shown in the figure, resonance may also occur at other frequencies near the resonant frequency, including ω_0, but the maximum response is at the resonant frequency. Also note that ω_r is only real and non-zero if ζ < 1 / 2 {\displaystyle \zeta