Answer to Question #69489, Physics / Electric Circuits

Question:

a) State the Barkhausen criterion for sustained oscillation. Explain the operation of Colpitt Oscillator. For a Colpitt oscillator with 10 MHz frequency determine the equivalent capacitance, C forming tank circuit with 0.1 mH inductor.
I assume that the L of the inductor is 0.1 micro Henry

Solution:

The Barkhausen criteria for sustained oscillation are:

1) The open loop gain of the amplifier multiplied by the feedback factor should be equal to one by modulus, ie $|A\beta| = 1$
2) The total phase shift around the loop should be equal to $2\pi N$, where N is an integer

A Colpitts oscillator is a device that generates sinusoidal output. It consists of an amplifier linked to a LC circuit or tank circuit. One of the advantages of this circuit is its simplicity; it needs only a single inductor and widely used in commercial signal generators upto 100 MHz.
The feedback needed for oscillation is taken from a voltage divider made of two capacitors. The frequency is determined by the Tank circuit and is varied by gang-tuning the two capacitors C_1 and C_2. As the tuning is varied, values of both capacitors vary simultaneously, the ratio of the two capacitances remaining the same.

The generation frequency of of the oscillator is calculated as

$$f = \frac{1}{2\pi}\sqrt{\frac{1}{L\left(\frac{C_1C_2}{C_1+C_2}\right)}}$$

The equvivalent frequency

$$C_{eq} = \left(\frac{C_1C_2}{C_1+C_2}\right) = \frac{1}{L(2\pi f)^2} = 25.33\ pF$$