

# DFEM-Computation of a Zero-point-energy Converter with realistic Parameters for a practical Setup

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## Abstract

A theoretical method for the computation of zero-point-energy converters has been presented as dynamic finite element method (DFEM) in [Tur 10a], [Tur 10b], but in these articles, only the method of computation has been described, without taking realizable parameters for an experimental setup into account. The way to calculate a realistic system for an experimental setup is developed here.

Therefore, the essential aspect is the question, how to control the speed of propagation of the interacting fields, which are responsible for the force, which drives the zero-point-energy converter. In the work presented here, these are the fields of the electromagnetic interaction, because for our example, a capacitor and a coil have to be adjusted in a way, that the frequency of an electromagnetic oscillation corresponds to the frequency of a mechanical oscillation. It depends on the precision of this adjustment, whether zero-point-energy is converted or not.

## 1. The method of dynamic finite elements “DFEM”

The DFEM-method was introduced in [Tur 10a] and [Tur 10b]. The first mentioned article explained the theoretical background, and the second one displayed an example, how to use this algorithm.

For the case of electromagnetic interaction, zero-point-energy converters can be calculated according to the classical rules of electrodynamics. The only difference between the classical FEM-engineering-methods and the new DFEM for zero-point-energy converters is the fact, that DFEM takes the finite speed of propagation of the fields of the electromagnetic interaction into account, which is a responsible for the forces between the different parts of the engine. Whereas the classical FEM engineering-calculations are based on the approximation, that the speed of propagation of the electromagnetic field is infinite, the DFEM calculations take the finite speed of propagation of the interaction into account. This is necessary because of the theory of relativity, which does not allow infinite speed by principle.

For classical purpose, the approximation of infinite speed of propagation of the interacting fields looks quite good, but in reality, this approximation is the reason, why classical electrodynamics is unable to compute or to understand zero-point-energy converters by principle. From the point of view of classical engines, the approximation of infinite speed of propagation sounds indeed sensible. If we imagine an electromotor, in which the attractive forces between stator and rotor have to act over a distance of  $s = 10\text{cm}$ , the propagation of the fields with the speed of light, as we expect it from the theory of relativity, will cause a time delay of only

$$t = \frac{s}{c} = \frac{0.1\text{m}}{3 \cdot 10^8\text{m}} = 0.333\text{nano Sec.} \quad (1)$$

On this background it looks absolutely normal, that engineers construct electromotors without taking the time delay in the range of fractions of nano-seconds into account.

But if we remember, that the approximation of infinite speed of propagation prevents engineers from understanding zero-point-energy converters, the situation appears totally different. From this point of

view, the approximation prevents mankind from making use of a new source of energy, which is absolutely free from environmental pollution and furthermore inexhaustible.

Of course it seems difficult to construct electromotors when taking the finite speed of propagation of the electromagnetic interaction (i.e. fields) into account. If the fields of the electromagnetic force propagates within the empty space, the computation of an electromotor should take fractions of nano-seconds into account as mentioned above - in order to discover a way, how to convert an utilize zero-point-energy. It is not surprising, that many colleagues regard this problem as too difficult or too useless, to work on its solution. Because of this, it is not surprising, that many colleagues do not take the possibility of the conversion of zero-point-energy into account at all. In order to demonstrate, that this problem can be solved by principle, the example in [Tur 10b] has been built up on a handy speed of propagation, in order to make it numerically easy. For the introduction of the computation-method as a basic research, this was sufficient, but it is not sufficient for an experimental verification. A practical setup, which can be experimentally analyzed, requires our ability, to take influence on the speed of propagation of the forces of the interaction, which drives the motor. For a real setup, the speed of propagation has to be much slower than the speed of light, in order to give us the possibility to handle the propagation-delay. From transmission line theory, the speed of propagation of the electrical impulses in wires is well known [Bau 10], [Kow 10], [Stö 10]), and it is slower than the speed of light. In modern computer-industry, this is already taken into account for the construction of modern semiconductor circuits.

If we can find a way, how we can control the speed of propagation of the electromagnetic interaction, we can get away from the dilemma of the fractions of nano-seconds according to (1). If we can decrease the speed of propagation of the interaction by several orders of magnitude relatively to the speed of light, we can get a time-delay for the propagation of the interaction-force, on which we can construct real engines. This is the aim of work, presented here.

## 2. How to control the speed of propagation of the interaction

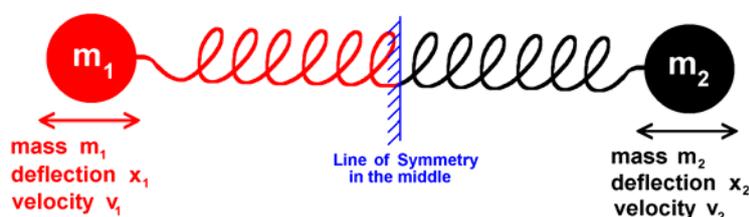
From transmission line theory, we know the speed of propagation of the interacting-fields to be (in a two wire transmission

$$v = \frac{1}{\sqrt{L' \cdot C'}} \quad \text{with } L' = \frac{L}{a} = \text{inductance per wire-length} \quad (2)$$

and  $C' = \frac{C}{a} = \text{capacitance per wire-length, where } a = \text{wire-length.}$

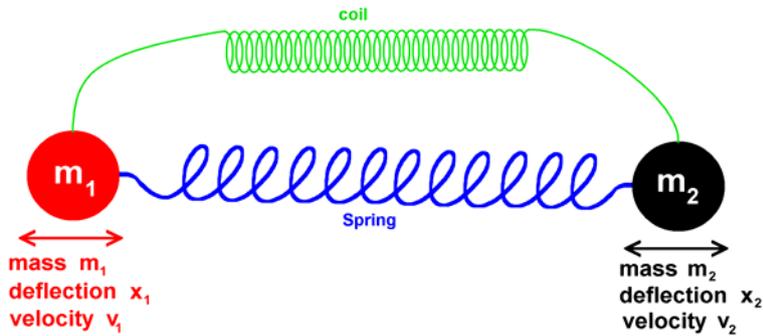
In order to get the speed of propagation as low as technically achievable, we need a setup with a large inductance and a large capacitance.

Fortunately, a setup with an inductance and a capacitance is a oscillating circuit, which is known very well, so that we can lead back our calculations to well-known facts [Tuc 10]. In order to arrange our example as clear as possible, we want to build it up on the example of [Tur 10b], which consists of two electrically charged bodies, forming the capacitor. We just have to add a coil (see Fig.1). For the sake of simplicity, we just want to alter the shape of the electrodes of the capacitor, which have been spheres. But not it is easier, to take two parallel plates, which might be connected with a helical spring. In figure 1, the speed of propagation of the electric field was determined by the vacuum, along which the field propagates. This situation is changed completely, as soon as we add the coil, because the coil and the capacitor are an oscillating circuit - and the circuit controls the speed of propagation of the electric signal within the wire – which limits the speed of propagation for our technical setup. This leads us to the setup shown in figure 2.



**Fig. 1:**

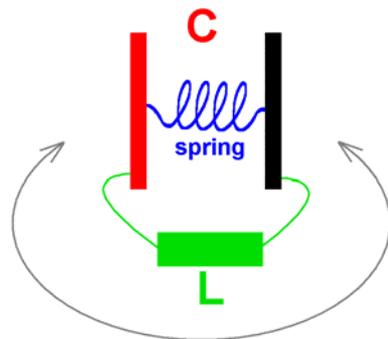
Two bodies, which are connected by a spring, can perform a harmonic oscillation. If the bodies are capacitor-plates, the setup can be used to convert zero-point energy.

**Abb. 2:**

A coil together with the capacitor-plates  $m_1, m_2$  forms an electric oscillation circuit, which is responsible for the oscillation of the electrical charge. But the coulomb forces between the capacitor-plates are influenced by their mechanical oscillation.

The crucial limit for the finite time delay of the forces of interaction is now the speed of propagation of the electrical charges within the wire, but not the speed of propagation of the fields within the vacuum. This is important, because it decides about the speed of propagation of the interactions, responsible for the functioning principle of the conversion of zero-point-energy.

The illustration according to figure 2 corresponds to the notation of mechanics. The notation of electricians follows rather to the illustration according to figure 3.

**Fig. 3:**

From the electrical point of view, the setup is a LC-oscillation circuit, which allows the capacitor-plates to oscillate mechanically, so that the capacity of the capacitor permanently varies as a function of time.

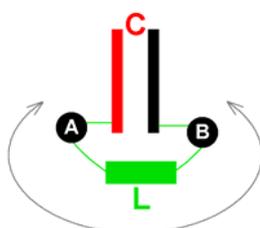
Nevertheless the oscillation of the electrical charge is dominantly determined by the LC-oscillation circuit, as marked with a double arrow in grey colour.

As can be seen in figure 3, the oscillation of the electrical charge is determined by the LC-oscillation circuit. Consequently the electrical field strength between the capacitor-plates follows the LC-oscillation circuit. Thus the electrostatic (Coulomb-) force between the plates is determined by the speed of propagation of the electrical charge in the green wire, from which the coil is made. The electrical field between the capacitor-plates is responsible for the attractive or repulsive forces between the plates. The behavior of these forces can thus be controlled by adjusting the inductance  $L$  and the capacitance  $C$  to the technical requirements of the setup. This is now our way, how we influence and control the speed of propagation of the interactive forces.

#### 4. The Algorithm for the simulation of the fields and bodies in motion

The source code of the DFEM-algorithm on which the research work presented here is based, is printed completely in the appendix. It is written in Delphi-Pascal [Bor 99]. The Physic's background, on which this algorithm was developed, is explained in sections 4 and 5.

We now follow the development of the simulation-algorithm (of the oscillation) step-by-step. The very first step just analyzes a harmonic oscillation within a simple LC-oscillation circuit. For this very first step, we will not take the motion of the capacitor-plates into account, and we neglect the Ohm's resistance of the wire, from which the coil is made. This very simple setup has the purpose, that we can check the results of the DFEM-algorithm by comparison with the classical oscillation circuit. Please see figure 4.

**Fig. 4:**

Simple classical LC-oscillation circuit as a preparation for our development of the DFEM-algorithm as described in the text. The simple setup can be checked with classical electrodynamics, in order to assure the correctness of the results. There is only one loop according to Kirchhoff's rules, namely "ACBLA".

For the computation of the discharge-procedure of the capacitor with finite speed, we can easily follow the classical considerations, which are based on the differential-equation of the classical LC-oscillation circuit. Therefore we apply Kirchhoff's voltage law, according to which the sum of all voltages within one closed loop is zero:

$$U_C + U_L = 0 \quad (3)$$

There the voltage over the capacitor and the voltage over the coil is:

$$\text{according to the definition of the capacitance } C = \frac{Q}{U} \Rightarrow U_C = \frac{1}{C} \cdot Q \quad (4)$$

$$\text{according to the induction-law: } U_L = -L \cdot \frac{d}{dt} I = -L \cdot \dot{Q} \quad (5)$$

$$\Rightarrow U_C + U_L = \frac{1}{C} \cdot Q - L \cdot \dot{Q} = 0 \text{ as differential equation of the harmonic oscillation.} \quad (6)$$

We want to solve the differential-equations by numerical iteration, because we want to prepare ourselves for the crucial case, in which the capacitance will be variable as a function of time. This case, which is the goal of our considerations, can not be solved analytically. The solution of the harmonic LC-oscillation is "part 1" of the source-code in the appendix. The initial conditions are well known, and we start our calculation at the moment  $t=0$ . From there on the time is running continuously and steps of  $\Delta t$ . The initial conditions consist in an electric charge being brought onto the capacitor plates, namely  $Q(t=0) = C \cdot U$  and  $\dot{Q}(t=0) = 0$  as well as  $\ddot{Q}(t=0) = 0$ .

The course of time is simulated as an iteration, step-by-step. Every step begins with the second derivative, influencing  $\ddot{Q}(t) = \dot{I}(t)$ , because the discharge current of the capacitor induces a voltage into the coil.

$$\ddot{Q}(t_i) = \frac{-U}{L} = \frac{-Q(t_{i-1})}{L \cdot C} \quad (7)$$

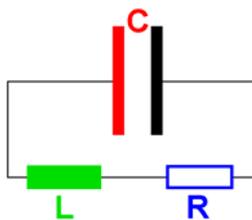
Two steps of integration lead us to

$$\dot{Q}(t_i) = \dot{Q}(t_{i-1}) + \ddot{Q}(t_i) \cdot \Delta t \quad \text{and} \quad (8)$$

$$Q(t_i) = Q(t_{i-1}) + \dot{Q}(t_i) \cdot \Delta t \quad (9)$$

By this means, the behaviour of the electrical charge is calculated as a function of time, step-by-step, according to the typical behaviour of an LC-oscillation circuit. Our considerations are determined by the finite speed, with which the electrical charge is propagating along the wire. Here, the differential-equations of the oscillation circuit is a comfortable way to realize the computer simulation of the propagation speed. By the way, the result of our iteration is identical with the classical solution of differential equation (6), so that it is not necessary to display the result graphically, because it is known generally.

The next step of our development is dedicated to Ohm's resistance of the coil, due to its copper wire. If the setup shall be verified experimentally, it would not be enough to calculate an idealized zero-point-energy converter without Ohm's resistance. In reality our setup has to convert enough zero-point-energy, that it will be sufficient to compensate real losses in the wire. For the development of the differential-equation for this situation, which still follows simple classical considerations, we have a look to figure 5.



**Fig. 5:**

Simple classical LC- oscillation circuit, taking losses due to Ohm's resistance of the wire into account, from which the coil is made.

We again apply Kirchhoff's voltage rule and say, that the sum of all voltages within our closed loop is zero:

$$U_L + U_R + U_C = 0 \quad (10)$$

There the voltage over the capacitor and the voltage over the coil is:

$$\text{according to the definition of the capacitance } C = \frac{Q}{U} \Rightarrow U_C = \frac{1}{C} \cdot Q \quad (11)$$

$$\text{according to the induction-law: } U_L = -L \cdot \frac{d}{dt} I = -L \cdot \ddot{Q} \quad (12)$$

$$\text{according to Ohm's law: } U_R = R \cdot I = R \cdot \dot{Q} \quad (13)$$

$$\Rightarrow U_L + U_R + U_C = -L \cdot \ddot{Q} + R \cdot \dot{Q} + \frac{1}{C} \cdot Q = 0 \quad \text{as differential equation of the attenuated oscillation.} \quad (14)$$

Due to these equations, we have to replace the differential equations of (7), (8) and (9) by

$$\ddot{Q}(t_i) = \frac{R}{L} \cdot \dot{Q}(t_{i-1}) + \frac{1}{L \cdot C} \cdot Q(t_{i-1}) \quad (15)$$

two steps of integration lead us to

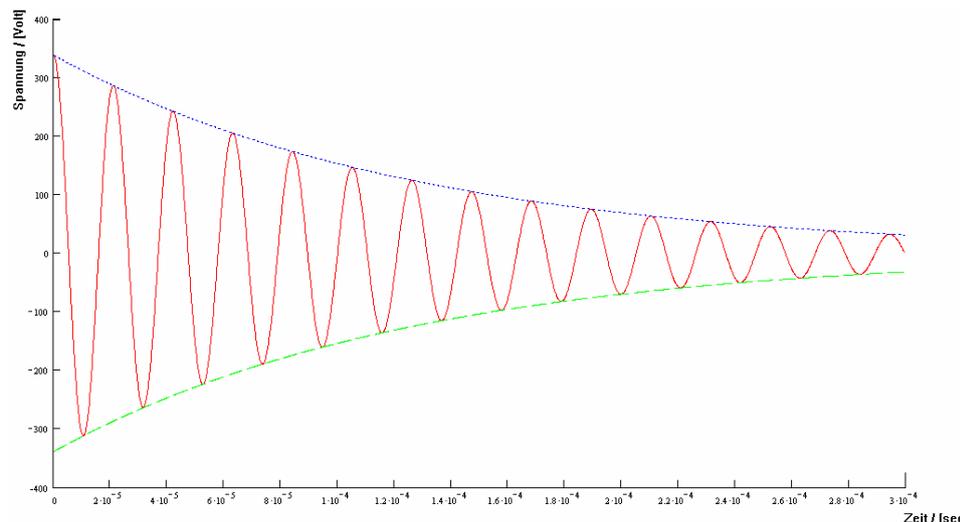
$$\dot{Q}(t_i) = \dot{Q}(t_{i-1}) + \left( \ddot{Q}(t_i) - \frac{R}{L} \cdot \dot{Q}(t_{i-1}) \right) \cdot \Delta t \quad \text{and} \quad (16)$$

$$Q(t_i) = Q(t_{i-1}) + \dot{Q}(t_i) \cdot \Delta t \quad (17)$$

Again we develop our solution as an iteration step-by-step during time, and again we come to the same result as the well-known classical computation, which is based on an analytical solution of the differential-equation. As generally known, Ohm's resistance has the consequence to decrease the propagation speed of the charge a little bit.

Remark: Please take notice, that in equation (16) the first derivative  $\dot{Q}$  occurs on the left side as well as on the right side. For the DFEM-algorithm, equation (16) has been reformed in order to dissolve it to  $\dot{Q}$  (as can be seen in the source-code).

For the example of the numerical values  $L = 0.126331 \text{ Henry}$ ,  $C = 8.85419 \cdot 10^{-11} \text{ Farad}$  and  $R = 2000 \Omega$  at an initial charge of the capacitor of  $Q(t=0) = 3 \cdot 10^{-8} \text{ C}$  (corresponding with a capacitor voltage of  $338.82 \text{ Volt}$ ), as well as the initial conditions  $\dot{Q}(t=0) = 0$  and  $\ddot{Q}(t=0) = 0$ , we come to the result as displayed in figure 6, which is the same for our algorithm and for the classical solution. Up to now, our DFEM-algorithm is developed only for the reproduction of generally known results, which has the purpose to verify its correctness.

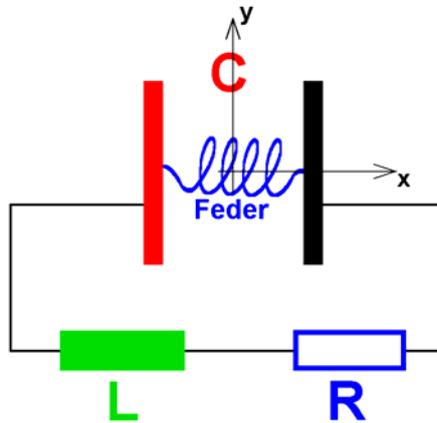


**Fig. 6:**  
Reproduction of a LCR-oscillation circuit with additional attenuation. The envelope curves in blue and in green represent the exponential decrease of the amplitude as a function of time.

By the way, the numerical values of the system-parameters are chosen with regard to a clear understanding of the current, and not with regard to the following applications of the algorithm in section 5.

## 5. DFEM-computation of the zero-point-energy converter from section 3

Within section 4, the preparation of our DFEM-algorithmus was verified successfully. Thus we can now come to the application of this algorithm, which is the LCR-oscillation circuit, with additional mechanical oscillation of the capacitor-plates according to figure 7. It differs from figure 2 and figure 3 because of the Ohm's resistance which is present now.



**Fig. 7:**

LCR- oscillation circuit, which does not follow an attenuated oscillation, because the variable capacitor does something different. Depending on the adjustment of the system parameters, energy can be converted between the zero-point-energy, electrical energy and mechanical energy. The direction, into which this conversion works, depends extremely sensitive on the adjustment of the mechanical oscillation and the electrical oscillation relatively to each other. Due to the time dependent variation of the capacitance  $C=C(t)$ , the differential equation can not longer be solved analytically, so that the iteration of the DFEM-algorithm is necessary.

The essential change with regard to the classical oscillation of figure 5 and figure 6 is the fact, that we now added a helical spring between the capacitor-plates, which causes a mechanical oscillation of these plates. Thus we now have to introduce this mechanical oscillation into our DFEM-algorithm. This requires some further expressions in our differential equation.

As we know, the differential equation of the mechanical oscillation is very similar to the differential equation of the electrical oscillation circuit. This allows us, to develop the differential equation of the mechanical oscillation in close analogy with equation (7), (8) and (9), with some supplements:

$$\ddot{x}(t_i) = \frac{-D}{m} \cdot \left( x(t_{i-1}) - \frac{CD}{2} \right) + \frac{1}{m \cdot 4\pi\epsilon_0} \cdot \frac{Q^2(t_i)}{(2 \cdot x(t_i))^2} \quad \begin{array}{l} \text{based on the spring-force and Coulomb's force} \\ \text{with } m = \text{mass and } D = \text{Hooke's spring-constant.} \end{array} \quad (18)$$

Two steps of integration now lead us to

$$\dot{x}(t_i) = \dot{x}(t_{i-1}) + \ddot{x} \cdot \Delta t \quad \text{and} \quad (19)$$

$$x(t_i) = x(t_{i-1}) + \dot{x}(t_i) \cdot \Delta t \quad (20)$$

The capacitor plates are mounted symmetrically with regard to the origin of coordinates, so that their positions are  $-x(t_i)$  and  $+x(t_i)$ . Thus we write Coulomb's force between the capacitor-plate as

$$F_C = \frac{1}{4\pi\epsilon_0} \cdot \frac{Q^2}{(2 \cdot x(t_i))^2}, \text{ because the distance between the capacitor plates is } 2 \cdot x(t_i).$$

For the calculation of the force of the helical spring, we have to use a totally different length, namely the alteration of the spring length relatively to the spring without load. If  $CD$  = length of the unloaded spring, the alteration of its length relatively to  $CD$  can be written as  $CD - 2 \cdot x(t_i)$ , not forgetting the algebraic sign of  $x(t_i)$ . If we regard the motion of the capacitor-plates a symmetrically with regard to the origin of coordinates, (where the coordinate-system is fixed in the middle of the capacitor, as shown in figure 7), each half of the spring follows exactly half of  $CD - 2 \cdot x(t_i)$ , so that the force of the spring, acting on each of the capacitor plates is  $F_F = -D \cdot \left( x(t_i) - \frac{CD}{2} \right)$ , as written in equation (18).

The mechanical parameters in the equations (18), (19) und (20) follow the mechanical mass of the capacitor plates and the spring force. The variation of the electrical charge  $Q(t)$  follows the electrical oscillation circuit. Thus,  $Q(t)$  in equation (18) is to be put into the formulas of the equations (15), (16), (17). By this means, that electric oscillation circuit influences the mechanical oscillation. But in the opposite direction, the mechanical oscillation of the capacitor plates influences the electrical oscillation circuit, because the mechanical distance between the capacitor plates also oscillates.

Indeed, this approach allows us, to convert zero-point-energy into classical energy back and forth. It also can be happen, that mechanical energy is converted into zero-point-energy and at the same time zero-point-energy is converted into electrical energy. Every imaginable configuration of energy conversion back and forth is possible. We will see this very clear, when we read the following explanations with regard to the DFEM-algorithm.

Let us start to put realistic parameters into the DFEM-algorithm:

For the capacitor:

- surface of the capacitor plates:  $A_C = 10\text{ cm} \times 10\text{ cm}$
- distance between the capacitor plates:  $d_C = 2\text{ mm}$

It would be possible to realize the capacitor by stretching a thin plastic foil with metal covering, on a frame of adequate thickness.

- dielectric between the capacitor plates:  $\varepsilon_r = 3$

This leads to a capacity of  $C = \varepsilon_0 \cdot \varepsilon_r \cdot \frac{A_C}{d_C}$ .

For the coil (cylindrical coil):

- length of the coil  $l_S = 8\text{ cm}$
- radius of the coil  $R_S = 5\text{ cm}$ , cross-section of the coil  $A_S = \pi \cdot R_S^2$
- number of windings  $n = 34600$
- magnetic core with permeability  $\mu_r = 12534$

This leads to an inductivity of  $L = \mu_0 \cdot \mu_r \cdot n^2 \cdot \frac{A_S}{l_S}$ .

For Ohm's resistance of the copper wire, from which the coil is made:

- specific resistance of copper  $\rho_{Cu} = 1.7 \cdot 10^{-8} \Omega \cdot m$  [Koh 96]
  - thickness of the wire  $D_d = 0.2\text{ mm} \Rightarrow$  cross-section of the wire  $A_D = \pi \cdot \left(\frac{D_d}{2}\right)^2$
- $\Rightarrow$  length of the coil's wire  $L_D = 2\pi R_S \cdot n$

This leads us to an Ohm's resistance of the copper wire of the coil  $R = \rho_{Cu} \cdot \frac{L_D}{A_D}$ .

For the mechanical oscillation of the capacitor plates:

- density of the plastic foil  $\rho_F = 1.5 \frac{\text{Kg}}{\text{cm}^3}$
- thickness of the plastic foil  $d_F = 10\ \mu\text{m}$
- density of the aluminium film on the plastic foil  $\rho_{Al} = 2.7 \frac{\text{Kg}}{\text{cm}^3}$
- thickness of the aluminium film on the plastic foil  $d_{Al} = 2\ \mu\text{m}$
- Hooke's spring constant of the foil  $D_H = 1.00 \frac{\text{N}}{\text{m}}$

$\Rightarrow$  mechanical mass of the capacitor plates  $m = A_C \cdot d_{Al} \cdot \rho_{Al} + A_C \cdot d_F \cdot \rho_F$

For the inertial conditions of the electric oscillation circuit:

- charge on the capacitor at the begin of the oscillation  $Q(0) = 2 \cdot 10^{-10}\text{ C}$

$\Rightarrow$  voltage on the capacitor at the begin  $U_C = \frac{Q}{C} = \frac{2 \cdot 10^{-10}\text{ C}}{1.328 \cdot 10^{-10}\text{ F}} = 1.50588\text{ Volt}$

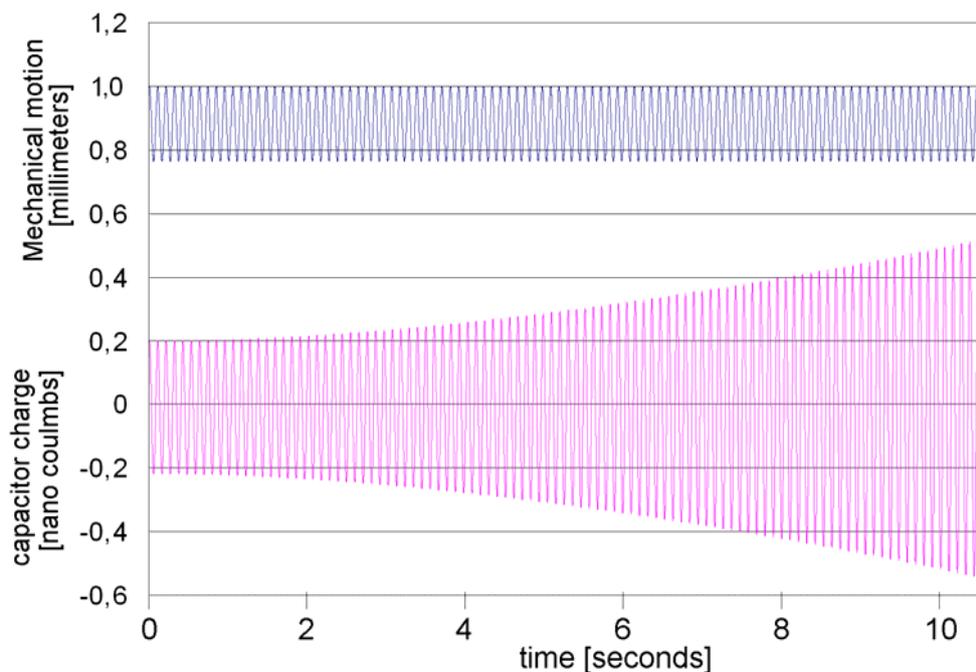
Of course these parameters can and should be varied within realistic limits. The values which are written here, are the basis for the computation of figure 8, where the purple curve describes the oscillation of the electric charge  $Q(t)$  in units of  $nC = 10^{-9} \text{Coulomb}$ , and the blue curve describes the mechanical oscillation of the capacitor plates as  $x(t_i)$  in units of  $mm = 10^{-3} m$ .

In order to adjust the system in a way that it converts zero-point-energy, both resonances have to be adjusted to each other, the resonance of the electric circuit and the resonance of the mechanical oscillation. Only if this “Double-resonance” is achieved, the conversion of zero-point-energy is possible.

If we remember, that the adjustment of one simple resonance can be difficult (such as for instance in a radio station), we understand the difficulties to adjust the “Double-resonance” which requires not only the adjustment of two resonances, but also the adjustment of both of them to each other. Thus we must realize, that the operation of a zero-point-energy converter not only requires an appropriate setup, but also a very difficult adjustment-procedure of the “Double-resonance”.

Thus an alteration of the system parameters acts very critical and sensitive on the operation of the zero-point-energy converter. Already very small alterations of some parameters can cause huge effects. Even our DFEM-algorithm requires the adjustment of several of the parameters with a precision of 4-5 significant figures, otherwise it would give weird results. On this background we now understand the technical difficulties and efforts, which many people have with operation of zero-point-energy converters. Not the manufacturing of the zero-point-energy converter is the central difficulty, but the proper adjustment to operate it. For instance Coler’s converter has been built up many times, but the adjustment was not reproduced until today. With our DFEM-algorithm it should be possible to compute, how the Coler-converter has to be adjusted [Hur 40], [Mie 84], [Nie 83].

Figure 8 shows an operation of our system with appropriate adjustment of the system parameters. (Their values are as stated above.) In this example, the amplitude of the mechanical oscillation increases only very slightly, but the amplitude of the electrical oscillation increases remarkably. But there is no classical energy supply with the setup, so that the energy for the increase of the amplitudes can only originate from the zero-point-energy of the quantum-vacuum.



**Fig. 8:** Oscillations of the both resonances connected with each other: In blue colour, we see the mechanical oscillation of the capacitor plates, and in red colour we see the electrical charge inside the capacitor plates. Both amplitudes increase without being supplied with classical energy.

A numerical evaluation of the DFEM-data, as presented in figure 8, leads us to the result, that the classical energy in the system is increasing. (And the new classical energy is originating from the zero-point energy of the quantum-vacuum, because there is no other energy supply connected with our setup.)

- At the time  $t_A = 0$  the system contains the energy, which it has got from the initial conditions. It is:
  - mechanical energy at the beginning  $W_{mech,A} = 1.981001 \cdot 10^{-8} \text{ Joule}$
  - electrical energy at the beginning  $W_{elektr,A} = 5.71700 \cdot 10^{-10} \text{ Joule}$
- At the time  $t_E = 10.59 \text{ sec}$ , the system contains more classical energy, which now is:
  - mechanical energy at the end  $W_{mech,E} = 1.981246 \cdot 10^{-8} \text{ Joule}$
  - electrical energy at the end  $W_{elektr,E} = 3.712196 \cdot 10^{-9} \text{ Joule}$
- This means that both types of classical energy increased during the time  $t_E - t_A = 10.59 \text{ sec}$  without being supplied from some classical energy source:
 
$$\Delta W_{mech} = W_{mech,E} - W_{mech,A} = 2.44 \cdot 10^{-12} \text{ Joule}$$

$$\Delta W_{elektr} = W_{elektr,E} - W_{elektr,A} = 3.1404 \cdot 10^{-9} \text{ Joule}$$
- The sum of the energy gain thus is  $\Delta W_{elektr} + \Delta W_{mech} = 3.1429 \cdot 10^{-9} \text{ Joule}$ .

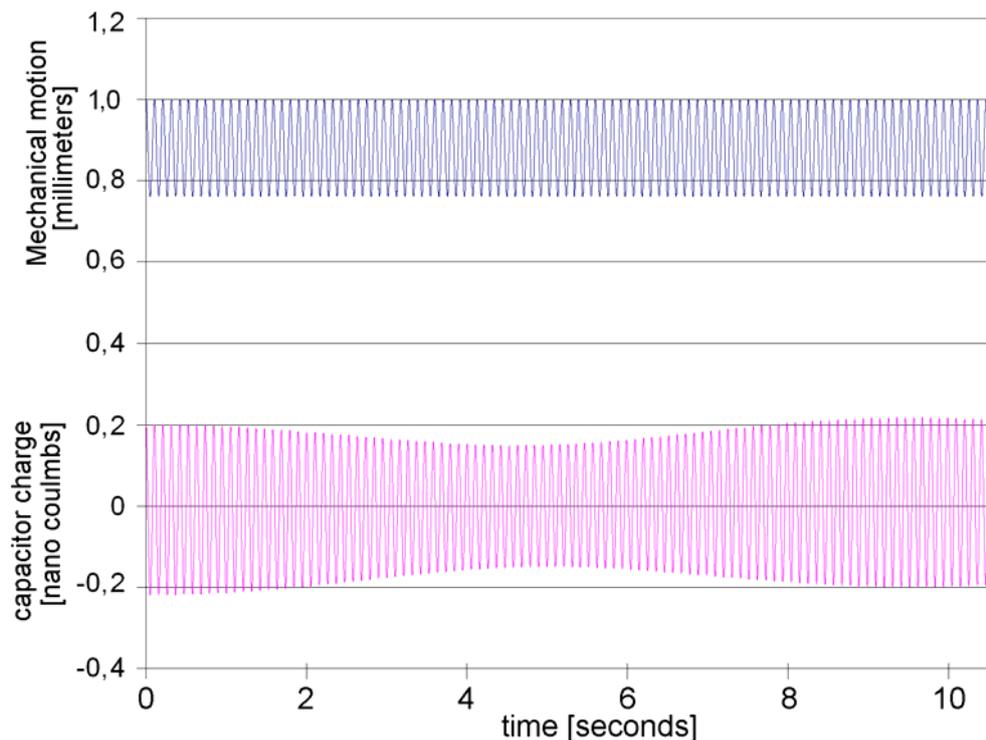
This is the amount of energy, which has been converted from the-zero-point energy of the quantum vacuum into classical energy, because there is no other energy source within our setup.

## 6. Crucial: Adjustment of the parameters and the dimensions of the system

It looks like the manufacturing of the zero-point-energy converter is not the most difficult point, but its operation is even more difficult. The problem is the adjustment of the system parameters, as we can understand from section 5. To demonstrate this more clearly, we can now perform small variations of the parameters within the DFEM-algorithm. Let us start with a small variation of Hooke's spring constant, which explains the only difference between figure 8 and figure 9:

- Hooke's spring constant  $D_H = 1.00 \frac{N}{m} \Rightarrow \text{Fig.8}$
- Hooke's spring constant  $D_H = 0.99 \frac{N}{m} \Rightarrow \text{Fig.9}$

All other parameters remained unchanged as a given in section 5.



**Fig. 9:** Other than in figure 8, we now do not observe a continuous conversion of zero-point-energy, but we now observe a conversion back and forth. At the beginning, classical energy is converted into zero-point-energy, but in the second half of the graph, the situation turns around.

Other than in figure 8, we observe in figure 9 the decrease of the mechanical energy. The electrical energy decreases rather visible in figure 9 during the first half on the analysis, but this decrease of the amplitudes causes a variation of the operation of the system by itself, so that the loss of classical energy can not be continued stable. After about 5 seconds, classical electrical energy is gained back from the zero-point-energy.

The fact, that the energy conversion phenomenon is not constant during time goes back to imperfections in the adjustment of the system parameters. The more precise the system parameters are adjusted, the longer we observe a continuous behaviour of the energy conversion, this means, the longer our system can run stable.

A possibility to get rid of this asynchronous behaviour of the resonances, which have to be adjusted to each other, is a periodical reset of the system, which can be given as a small amount of control-energy (for instance as a short electrical pulse), which brings the system back into a well defined initial state from time to time (example: [Kep 10], [Hor 10]).

In order to demonstrate, how the energy-conversion can be brought into different directions, just following the adjustment of the system parameters, table 1 was calculated. Please see the algebraic sign of the conversion from line to line.

line	INPUT: System-Parameters			OUTPUT: System-Reaction		Remark
	spring constant	permeability		$\Delta W_{mechan}$	$\Delta W_{elektr}$	
1	$D_H = 1.00 \frac{N}{m}$	$\mu_r = 12534$	$\Rightarrow$	$+2.44 \cdot 10^{-12} J$	$+3.129 \cdot 10^{-9} J$	see fig.8
2	$D_H = 1.00 \frac{N}{m}$	$\mu_r = 12770$	$\Rightarrow$	$+2.44 \cdot 10^{-12} J$	$+1.103 \cdot 10^{-12} J$	
3	$D_H = 1.00 \frac{N}{m}$	$\mu_r = 12430$	$\Rightarrow$	$+2.44 \cdot 10^{-12} J$	$-4.23 \cdot 10^{-10} J$	
4	$D_H = 0.99 \frac{N}{m}$	$\mu_r = 12534$	$\Rightarrow$	$-3.24 \cdot 10^{-12} J$	$-2.84 \cdot 10^{-11} J$	see fig.9

Table 1: Reaction of the energy-converter-system on variations of the system-parameters

Obviously, even very small variations of the system parameters can have such huge effect, that they even may change the direction of the energy conversion. In table 1 we find:

In line 1  $\rightarrow$  increase of mechanical energy, and increase of electrical energy  
 In line 2  $\rightarrow$  increase of mechanical energy, and increase of electrical energy  
 In line 3  $\rightarrow$  increase of mechanical energy, but decrease of electrical energy  
 In line 4  $\rightarrow$  decrease of mechanical energy, and decrease of electrical energy

Arbitrary combinations are possible, which even do not have to remain constant during time. Their behaviour depends extremely sensitive on the quality of the adjustment of the system parameters.

## 7. The speed of propagation of the fields of the interactions

In our example, the important interaction is the electromagnetic one. The electric charge, which is responsible therefore, determines with its motion along the wire, the speed of propagation of the interaction. The distance for this motion is the length of the wire, from which the coil is made. If we follow transmission line theory, the speed of propagation of the voltage-pulses (same as the field-pulses) within the wire will be the crucial speed responsible for the electromagnetic interaction, because it is responsible for the limitation of the speed of interaction, because it is the slowest component in the system. And this speed of interaction is not the vacuum speed of light, but the speed of motion of the (charge induced) voltage-pulses along the wire. We are curious to estimate this speed now.

- The length of the wire, from which the coil is made, can be calculated from the number of windings and the length of each winding (where we use the symbols and the values from section 5):

$$\text{Length of the wire in the coil } L_D = 2\pi R_S \cdot n = 2\pi \cdot 0.05m \cdot 34600 = 10870m . \quad (21)$$

(In reality, the wire is a bit longer, because the outer windings have a radius which is a bit larger.)

- The duration for the propagation of the signal is known from the frequency of the oscillation, respectively from the duration per each period  $T$ . During the duration of one period of the oscillation, the electrical charge is moving once forth and once back, this is twice the length of the wire  $L_D$ . By evaluating the figures 8 and 9, we find:
  - in fig.8  $\rightarrow$  101 periods of electrical oscillation
  - in fig.0  $\rightarrow$  100.5 periods of electrical oscillation

The difference of half a period also causes the difference in energy conversion, and it has its reason from the influence of the electrical circuit and the mechanical circuit onto each other. Thus, for our estimation, we can use the arithmetic average of both:

$$\text{Duration per period } T = \frac{10.59\text{sec.}}{100.75\text{Perioden}} = 0.105112 \frac{\text{sec.}}{\text{Periode}} \quad (22)$$

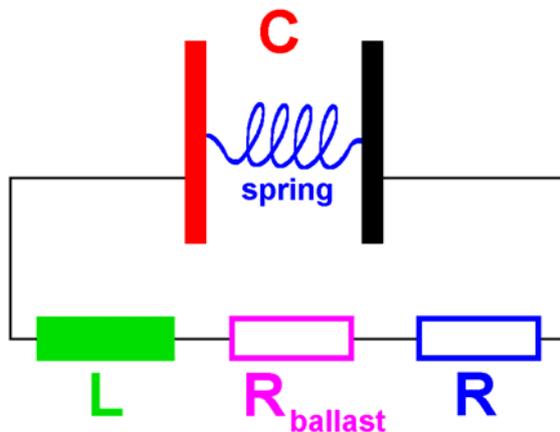
- The speed of propagation of the charge along the wire, which defines the speed of propagation of our system, then is

$$v = \frac{2 \cdot L_D}{T} = \frac{2 \cdot 10870m}{0.105112\text{sec.}} = 206.8 \frac{km}{\text{sec.}} = 6.89 \cdot 10^{-4} c . \quad (23)$$

It is only a small fraction of the speed of light. On the one hand this demonstrates, how strongly the speed of propagation of the interaction fields can be influenced, and how the speed of propagation of these fields can be brought into a range, within which we can operate. But on the other hand, the result also displays very clearly, how sensitive the speed of propagation acts on the conversion of zero-point-energy. Thus it is necessary to determine this speed directly from the system. Therefore the differential equations of the oscillations are not only convenient but really necessary. Not the length of the wire is of main importance, but many other physical values of the system. (Just have the permeability of the magnetic core inside the coil as an example therefore in mind.)

## 8. The gain of classical electrical power

In order to extract electrical power from the system, which is now operating as a self-running engine, we introduce a ballast resistor into the circuit, as drawn in figure 10.



**Fig. 10:**

A ballast resistor  $R_{ballast}$  has been added to our zero-point energy circuit, which is connected in series with the copper wire of the coil and its Ohm's resistance  $R$ . The ballast resistor permanently extracts energy from the zero-point-energy converter. Within our DFEM-algorithm, it is sufficient to add the resistances  $R$  and  $R_{ballast}$  linear.

If the ballast resistor is chosen to be  $R_{ballast} = 334k\Omega$ , the system parameters from section 5 and figure 8 will lead us to an energy gain of  $P = 2.32 \cdot 10^{-11} Watt$ . The ballast resistor has been chosen in such a way, that the amplitude of the electrical voltage (over the capacitor) is kept constant, in order to maintain constant operation during time. The capacitor voltage has an amplitude of  $U_C = 1.50 Volt$ .

The electrical power has been calculated as integral average value. Because of Kirchhoff's voltage law, the electrical current is the same in all electrical elements of the circuit. Thus the computation of the converted power goes back to the formulas

$$P = U \cdot I = R_{ballast} \cdot I^2 = R_{ballast} \cdot \dot{Q}^2$$

$$\Rightarrow \text{extracted energy } \bar{E} = \int_0^{10.59\text{sec}} R_{ballast} \cdot \dot{Q}(t)^2 dt \quad . \quad (24)$$

$$\Rightarrow \text{mean value of converted power } \bar{P} = \frac{\bar{E}}{10.59\text{sec}}$$

The converted power, as we calculated it, is rather small, and thus we want to increase it. This is indeed no problem, because the maximum of the voltage over the capacitor (i.e. the amplitude of the voltage) is only  $U_C = 1.50\text{Volt}$ . This can be enhanced very easy. If we enhance the capacitor voltage only up to  $U_C = 2.00\text{Volt}$  (amplitude) and then adjust the system parameters as good as necessary, we get a remarkable enhancement of the power. Please see the following comparison:

►  $U_C = 1.50\text{Volt}$ ,  $D = 1.000 \frac{N}{m}$ ,  $Q(0) = 2.000 \cdot 10^{-10} C$  at  $R_{Last} = 334k\Omega$  (with  $\mu_r = 12534$ )

$\Rightarrow P_{ballast} = 2.32 \cdot 10^{-11} \text{Watt}$  extraction by the ballast resistor and  $E_{circuit} = 9.6 \cdot 10^{-12} \text{Joule}$  in the capacitor  
Thus the power being converted from the zero-point-energy under this operation is

$$P_{ballast} + \frac{E_{circuit}}{\Delta t} = 2.32 \cdot 10^{-11} \text{Watt} + \frac{9.6 \cdot 10^{-12} \text{Joule}}{10.59\text{sec.}} = 2.41 \cdot 10^{-11} \text{Watt} .$$

►  $U_C = 2.00\text{Volt}$ ,  $D = 1.341 \frac{N}{m}$ ,  $Q(0) = 2.665 \cdot 10^{-10} C$  at  $R_{ballast} = 230k\Omega$  (with  $\mu_r = 12539$ )

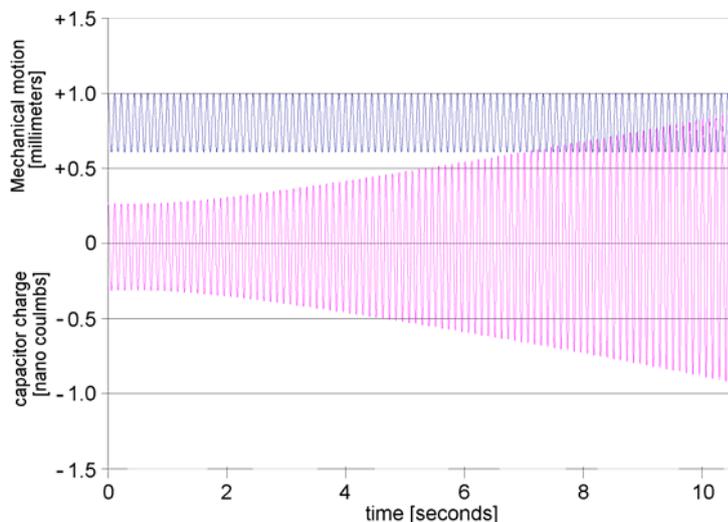
$\Rightarrow P_{ballast} = 1.278 \cdot 10^{-10} \text{Watt}$  extraction by the ballast resistor and  $E_{circuit} = 1.16 \cdot 10^{-8} \text{Joule}$  in the capacitor

plus  $E_{mech} = 9.13 \cdot 10^{-12} \text{Joule}$  mechanically

Thus the power being converted from the zero-point-energy under this operation is

$$P_{ballast} + \frac{E_{circuit} + E_{mech}}{\Delta t} = 1.278 \cdot 10^{-10} \text{Watt} + \frac{1.16 \cdot 10^{-8} \text{Joule}}{10.59\text{sec.}} = 1.22 \cdot 10^{-9} \text{Watt}$$

- Obviously an enhancement of the capacitor voltage-amplitude from 1.5 Volt to 2.0 Volt even leads to an enhancement of the converted power by more than a factor of 50. This shows us, how much optimization is possible.



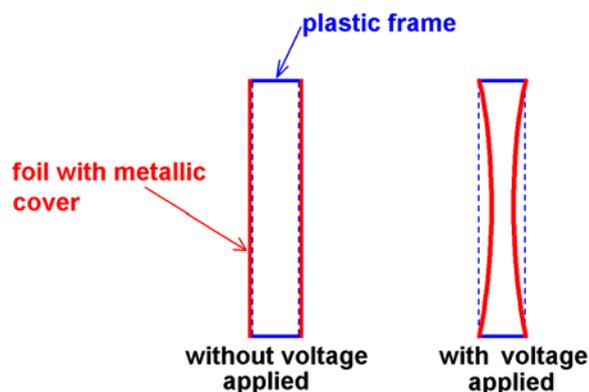
**Abb.11:**

Electrical and mechanical oscillation of our setup at a capacitor voltage-amplitude of  $U_C = 2.00 \text{ Volt}$ .

Interestingly, an enhancement of the ballast resistor (same as a decrease of this resistor) does not enhance the power being extracted from the quantum-vacuum (as we would expect from  $P = R_{ballast} \cdot I^2$ ). The opposite is the case, because the ballast resistor also influences (and disturbs) the “Double resonance”. In our example the ballast resistor was adjusted with regard to a maximization of the extraction of power from the quantum-vacuum.

For the optimization of the operation-mode of the zero-point-energy converter has to be adjusted for each experiment individually, depending on the available materials and dimensions, the present work contains the source-code of the DFEM-algorithm, so that every dexterous experimentalist can optimize the setup for his or her own purpose. But please keep in mind, that an enhancement of the capacitor-voltage always increases the attractive forces between the capacitor-plates, which makes it necessary to enhance also the stiffness of the spring between the capacitor-plates (which can be the stiffness of the capacitor-plates themselves), in order to avoid a contact between the both capacitor plates. This is a very sensitive aspect with regard to this setup.

The capacitor should not have the too small capacitance. This makes it necessary to mount the capacitor-plates not too far away from each other. This can be done rather easy by the use of two pieces of a thin plastic foil, which can be stretched on both sides of a wooden or plastic frame. The metallic plates can just consist of thin metallic films on the surface of the plastic foils. On this background, you can understand the computation of the mass of the capacitor plates as well as the Hooke’s spring constant of these capacitor-plates in the source-code of the algorithm (see also fig.12). The pre-stress of the plastic foil determines their spring constant.



**Fig. 12:**

Suggestion for an experimental setup of a capacitor with flexible plates, which have a rather small distance between each other in order to get a not too small capacity.

## Resumée

Summarizing what we learn from this work, it can be said, that the speed of propagation of the interacting forces in electro-magnetic engines can be controlled in a rather wide range, so that it is possible, to build efficient electro-magnetic zero-point-energy converters. The basic principles have been explained in the work presented here, together with an example for their illustration.

However, the adjustment of the system parameters is a considerable problem. It is necessary to adjust these parameters extremely precise relatively to each other and also within the system, because several resonances have to be adjusted to each other. This teaches us, that the adjustment of the parameters might be even more difficult, than the manufacturing of the zero-point-energy converter itself. Trigger-pulses, which do not consume much energy, might be a good help for a zero-point-energy converter to run stable.

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## Appendix: The source code of the DFEM-algorithm

```

Program Harmonischer_Oszillator_im_DFEM;
{$APPTYPE CONSOLE}
uses
  Windows, Messages, SysUtils, Classes, Graphics, Controls, Forms, Dialogs;

Var epo,muo      : Double;  {Constants of nature}
    v            : Double;  {Propagation-speed of the charges}
    CA,CD,C      : Double;  {Capacitor: surface and distance of the plates, capacity}
    GG3         : Double;  {equilibrium position of the flexible plates, part 3}
    SP3         : Double;  {distance of the plates with initial voltage}
    UC,UL{,UR}  : Double;  {voltage of the capacitor, coil, resistor}
    SN,SL,SA,SR : Double;  {coil: windings, length, cross-section, Radius}
    L           : Double;  {inductivity of the coil}
    DL          : Double;  {length of the copper wire}
    epr,mur     : Double;  {Epsilon_r und Mü_r for capacitor and coil}
    rho,R       : Double;  {specific resistance of the copper wire}
    AD          : Double;  {cross-section of the copper wire}
    Q,Qp,Qpp   : Array[0..200000] of Double; {charge and derivatives as a function of time}
    x,xp,xpp   : Array[0..200000] of Double; {deflection of the capacitor-plates}
    dt         : Double;  {time step-by-step}
    N          : LongInt; {number of time-steps}
    i          : LongInt; {counter}
    Abstd      : Integer; {plot-counter}
    rhoAL,rhoFol: Double; {density of aluminium and plastic foil}
    dAL,dFol   : Double; {thickness of aluminium and plastic foil}
    D          : Double;  {spring constant}
    m          : Double;  {(mechanical) mass of the capacitor plates}
    omfol,fFol : Double;  {oscillation frequency}
    F          : Double;  {force between the capacitor plates}
    Sternl     : Double;  {variable}
    Fc,Fd      : Double;  {coulomb force and spring force}
    MacheFiles : Boolean; {data-storage yes/no ?}
    om         : Double;  {Omega}
    Rlast      : Double;  {ballast resistor}

Procedure Wait;
Var Ki : Char;
begin
  Write('<W>'); Read(Ki); Write(Ki);
  If Ki='e' then Halt;
end;

Procedure Excel_Datenausgabe(Name:String);
Var fout : Text;    {prepare data for Excel}
    Zahl : String;
    lv,j : Integer; {variable}
    A0   : Double;  {Amplitude}
begin { prepare data for Excel;}
  Assign(fout,Name); Rewrite(fout); {File open}
  For lv:=0 to N do {from "plotanf" to "plotend"}
  begin
    If (lv mod Abstd)=0 then
    begin
      { the first argument is the time:}
      Str(lv*dt*1e6{nafo_sec.}:14:10,Zahl);
      For j:=1 to Length(Zahl) do
      begin {uns commata}
        If Zahl[j]>'.' then write(fout,Zahl[j]);
        If Zahl[j]='.' then write(fout,',');
      end;
      Write(fout,chr(9)); {Data-separation}
      { the first function is the voltage:}
      Str(Q[lv]/C{Volt}:14:7,Zahl);
      For j:=1 to Length(Zahl) do
      begin {use commata}
        If Zahl[j]>'.' then write(fout,Zahl[j]);
        If Zahl[j]='.' then write(fout,',');
      end;
      Write(fout,chr(9)); {Data-separation}
      { second function: envelope}
      A0:=Q[0]/C/sin(arctan(sqrt(1/L/C-R*R/4/L/L)/(R/2/L))); {klassische}
      Str(A0*exp(-R/2/L*lv*dt){Volt}:20:10,Zahl); {Formeln}
      For j:=1 to Length(Zahl) do
      begin {use commata}
        If Zahl[j]>'.' then write(fout,Zahl[j]);
    
```

```

        If Zahl[j]='.' then write(fout,',' );
    end;
    Writeln(fout,',' );    {line-separation }
end;
end;
Close(fout);
end;

Procedure Excel_andere_Ausgabe(Name:String);
Var fout : Text;    {prepare data for Excel}
    Zahl : String;
    lv,j : Integer; {variable}
begin {prepare data for Excel:}
    Assign(fout,Name); Rewrite(fout); {File open}
    For lv:=0 to N do {from "plotanf" to "plotend"}
    begin
        If (lv mod Abstd)=0 then
        begin
            {
                the first argument is the time:}
            Str(lv*dt*1e6{nano_sec.}:14:10,Zahl);
            For j:=1 to Length(Zahl) do
            begin {use commata}
                If Zahl[j]<>'.' then write(fout,Zahl[j]);
                If Zahl[j]='.' then write(fout,',' );
            end;
            Write(fout,chr(9)); {Data- separation }
            {
                first Funktion: }
            Str(x[lv]{Volt}:20:14,Zahl);
            For j:=1 to Length(Zahl) do
            begin {use commata}
                If Zahl[j]<>'.' then write(fout,Zahl[j]);
                If Zahl[j]='.' then write(fout,',' );
            end;
            Write(fout,chr(9)); {Data-separation }
            {
                second Funktion: }
            Str(Q[lv]*1E6{Volt}:20:14,Zahl);
            For j:=1 to Length(Zahl) do
            begin {use commata}
                If Zahl[j]<>'.' then write(fout,Zahl[j]);
                If Zahl[j]='.' then write(fout,',' );
            end;
            Writeln(fout,',' );    {line-separation }
        end;
    end;
    Close(fout);
end;

Procedure Excel_Raumenergieausgabe(Name:String);
Var fout : Text;    {prepare data for Excel}
    Zahl : String;
    lv,j : Integer; {variable}
begin {prepare data for Excel:}
    Assign(fout,Name); Rewrite(fout); {File open}
    For lv:=0 to N do {from "plotanf" to "plotend"}
    begin
        If (lv mod Abstd)=0 then
        begin
            {
                the first argument is the time:}
            Str(lv*dt*1e6{nano_sec.}:14:10,Zahl);
            For j:=1 to Length(Zahl) do
            begin {use commata}
                If Zahl[j]<>'.' then write(fout,Zahl[j]);
                If Zahl[j]='.' then write(fout,',' );
            end;
            Write(fout,chr(9)); {Data-separation}
            {
                the first function is the voltage:}
            Str(x[lv]{Volt}:14:7,Zahl);
            For j:=1 to Length(Zahl) do
            begin {use commata}
                If Zahl[j]<>'.' then write(fout,Zahl[j]);
                If Zahl[j]='.' then write(fout,',' );
            end;
            Writeln(fout,',' );    {line-separation }
        end;
    end;
    Close(fout);
end;

Procedure Excel_eine_Kolumne(Name:String);

```

```

Var fout   : Text;      {prepare data for Excel}
    Zahl   : String;
    lv,j   : Integer; {variable}
begin {prepare data for Excel;}
    Assign(fout,Name); Rewrite(fout); {File open}
    For lv:=0 to N do {from "plotanf" to "plotend"}
    begin
        If (lv mod Abstd)=0 then
        begin
            Str(x[lv]{Volt}:20:14,Zahl); {write the array to be plotted here.}
            For j:=1 to Length(Zahl) do
            begin {use commata}
                If Zahl[j]<>'.' then write(fout,Zahl[j]);
                If Zahl[j]='.' then write(fout,',');
            end;
            Writeln(fout,','); {line-separation}
        end;
    end;
    Close(fout);
end;

Function Plapos(z:LongInt):Double; {Iterative determination of the plate's position.}
Var xs     : Double; {initial value}
    sw     : Double; {Stepp-width}
    an,ab  : Boolean;
begin
    xs:=0;
    If z=0 then xs:=CD/2; {the position of the plates is at +/-xs.}
    If z>0 then xs:=x[z-1]; {this can eventually be taken from the last step.}
    sw:=xs/20;
    Repeat
        sw:=sw/10;
        an:=false; ab:=false;
        Repeat
            Fc:=1/4/pi/epo*q[z]*q[z]/(2*xs)/(2*xs);
            Fd:=D*(xs-CD/2); {deflection of the spring with regard to CD.}
            If Fc+Fd>0 then begin xs:=xs-sw; an:=true; end;
            If Fc+Fd<0 then begin xs:=xs+sw; ab:=true; end;
            If xs<=1e-10 then
            begin
                Writeln('Capacitor plates touch each other. Coulomb-force too strong. STOP. ');
                Wait; Wait; Halt;
            end;
        Until (an and ab);
    Until (sw<xs/1e14);
    Plapos:=xs;
end;

Procedure Amplituden_anzeigen;
Var i           : Integer;
    schreibe    : Boolean;
    SteigX,SteigQ : Boolean;
    BildX,BildQ  : Array[0..200] of Double;
    zvx,zvQ     : Integer;
    eq,lq,ex,lx  : Double;
    Wmech1,Wmech2,Well,Well2:Double;
begin
    { first that x-Amplitudes:}
    SteigX:=false; If x[1]>x[0] then SteigX:=true;
    schreibe:=false; zvx:=0;
    Writeln('      I:   t/[sec.] |           x/[m]           |           Q[i]');
    For i:=1 to N do
    begin
        If SteigX then
        begin
            If x[i]<x[i-1] then begin schreibe:=true; SteigX:=Not(SteigX); Write('X-Max:'); end;
        end;
        If Not(SteigX) then
        begin
            If x[i]>x[i-1] then begin schreibe:=true; SteigX:=Not(SteigX); Write('X-Min:'); end;
        end;
        If schreibe then
        begin
            Writeln(i:6,': ',i*dt:7:5,' | ',x[i],' | ',Q[i]); {Wait;}
            BildX[zvx]:=x[i]; zvx:=zvx+1;
        end;
        schreibe:=false;
    end;
    zvx:=zvx-1;

```

```

{ then the Q-Amplitudes:}
SteigQ:=false; If Q[1]>Q[0] then SteigQ:=true;
schreibe:=false; zvQ:=0;
Writeln(' I: t/[sec.] | x/[m] | Q[i]');
For i:=1 to N do
begin
  If SteigQ then
  begin
    If Q[i]<Q[i-1] then begin schreibe:=true; SteigQ:=Not(SteigQ); Write('Q-Max:'); end;
  end;
  If Not(SteigQ) then
  begin
    If Q[i]>Q[i-1] then begin schreibe:=true; SteigQ:=Not(SteigQ); Write('Q-Min:'); end;
  end;
  If schreibe then
  begin
    Writeln(i:6,' ',i*dt:7:5,' | ',x[i],' | ',Q[i]); {Wait;}
    BildQ[zvQ]:=Q[i]; zvQ:=zvQ+1;
  end;
  schreibe:=false;
end;
zvQ:=zvQ-1;
{ overview over "amplitudes":}
Writeln('pos., amplitudes : ');
i:=2; ex:=BildX[i]-BildX[i-1];
Repeat
  Writeln(i,' ',BildX[i]-BildX[i-1]);
  lx:=BildX[i]-BildX[i-1];
  i:=i+2;
Until (i>=zvx);
Writeln('charges , amplitudes : ');
i:=2; eq:=BildQ[i]-BildQ[i-1];
Repeat
  Writeln(i,' ',BildQ[i]-BildQ[i-1]);
  lq:=BildQ[i]-BildQ[i-1];
  i:=i+2;
Until (i>=zvQ);
Write('total alteration, X -Amplitude: ');
If Abs(lx)>Abs(ex) then Write('+');
If Abs(lx)<Abs(ex) then Write('-');
om:=pi*zvx/N/dt; Writeln('ang.frequency omega= ',om);
Writeln(Abs(lx-ex));
Wmech1:=m/2*(ex*ex)*om*om; Wmech2:=m/2*(lx*lx)*om*om;
Writeln('Mechanical energy at Begin : ',Wmech1,' Joule');
Writeln('Mechanical Energy at End : ',Wmech2,' Joule');
Writeln('Mechan. Energy-alteration : ',Wmech2-Wmech1,' Joule');
Write('total change, charge -Amplitude: ');
If Abs(lq)>Abs(eq) then Write('+');
If Abs(lq)<Abs(eq) then Write('-');
Writeln(Abs(lq-eq));
Well1:=L/2*(eq*eq)*om*om; Well2:=L/2*(lq*lq)*om*om;
Writeln('Elektrical Energy at Begin : ',Well1,' Joule');
Writeln('Elektrical Energy at End : ',Well2,' Joule');
Writeln('Elektr. Energy-alteration : ',Well2-Well1,' Joule'); Writeln;
Writeln('Sum: total energy-gain : ',Wmech2-Wmech1+Well2-Well1,' Joule'); Writeln;
end;

Procedure Leistung_berechnen; {over the ballast resistor "Rlast", Integral average}
Var i : Integer;
P : Double; {power in the time interval dt}
Eges: Double; {total power over the total time}
begin
  Eges:=0;
  For i:=0 to N do
  begin
    P:=+Rlast*Qp[i]*Qp[i];
    Eges:=Eges+P*dt;
  end;
  Writeln('Eges= ',Eges, ' Joule in ',N*dt,' sec. ');
  Writeln('=> power Pmean = ',Eges/(N*dt),' Watt');
end;

Begin {main program}
{ Initialization of the values: }
{ General: }
epo:=8.854187817E-12{As/Vm}; {Magnetic Field constant}

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muo:=4*pi*1E-7{Vs/Am};           {Elektric Field constant }
v:=Sqrt(1/muo/epo){m/s};        {speed of light}
Abstd:=1;                         {how many points shall be plotted ?}
{ Kondensator: }
CA:=0.1*0.1{m^2}; CD:=0.002{m};  {capacitor-Geometrie, plate's surface & distance}
epr:=3;                            {Dielectric isinde capacitor}
C:=epo*epr*CA/CD;                {capacity without voltage}
{ Spule: }
SN:=34600; SL:=0.08{m}; SR:=0.05{m}; SA:=pi*SR*SR{m^2};           {coil's-Geometry}
{ }mur:=12534;                    {core material to adjust the frequency}
L:=muo*mur*SN*SN*SA/SL;          {inductance}
rho:=1.7E-8{Ohm*m};              {Spez. resistance of copper, Kohlrausch,T193}
AD:=pi*0.0002*0.0002{m^2};      {cross-section of the copper wire}
R:=rho*2*pi*SR*SN/AD{Ohm};      {Ohm`s resistance of the copper wire}
DL:=SN*2*pi*SR;                  {length of the copper wire}
{mechanical oscillations of the capacitor plates:}
rhoAL:=2700{kg/m^3};             {density of Aluminium}
rhoFol:=1500{kg/m^3};           {density of plastic foil}
{ }dAL:=2e-6{m};                 {thickness of Aluminium-capacitor plates}
{ }dFol:=10e-6{m};               {thickness of the plastic foil}
{ }D:=1.0{N/m};                   {Hooke's spring constant of the capacitor plates}
m:=CA*dAL*rhoAL+CA*dFol*rhoFol; {(mechanical) mass of the Aluminium-capacitor plates}
omFol:=Sqrt(D/m);                {mechanical frequency of the capacitor plates}
fFol:=omFol/2/pi;                {mechanical frequency of the capacitor plates}
{ extraction of electrical power:}
Rlast:=0;                        {Ohm}                                {electrical ballast resistor}
{start of the electrical oscillation: }
{ }Q[0]:=2E-10{C}; Qp[0]:=0; Qpp[0]:=0;                               {initial charge on the capacitor}
UC:=Q[0]/C{V};                   {initial voltage of the capacitor}
dt:=3.53E-4{sec.};               {Time-steps}
N:=30000;                          {total number of Time-steps}
{ start of the mechanical oscillation: }
x[0]:=Plapos(0);                  {Iterative determination of the position of the capacitor plates.}
GG3:=x[0]; {equilibrium position of the flexible plates, part 3, Federkraft=Coulombkraft}
SP3:=CD/2;                         {distance of the plates with regard to mechanical prestress}
F:=1/4/pi/epo*Q[0]*Q[0]/(2*x[0])/(2*x[0]); {Anziehung nach dem Coulomb-Gesetz}
                                     {the position of the plates is at CD/2+x[i]}
xp[0]:=0; xpp[0]:=0;              {initial conditions of the plates motion t=0}
MacheFiles:=true;                 {should we write the results for Excel ?}
{screen outputs of initial data:}
Writeln('DFEM-computation of LC - oscillation:'); Writeln;
Writeln('epo=',epo:20,'; muo=',muo:20,'; v=',v:20);
Writeln('C=',C:20,' Farad; L=',L:20,' Henry');
Writeln('Klass. Elek. Osc. frequ. fo=2*pi/Sqrt(L*C)=' ,2*pi/Sqrt(L*C),' Hz');
Writeln(' ==> duration per period T=1/fo=' ,2*pi*Sqrt(L*C),' sec. ');
Writeln('Ohm`s resistance of the copper-wire:',R,' Ohm');
Writeln('length of the copper wire:',DL,' Meter');
Writeln('cross-section of the copper wire:',AD*1e6:10:5,' mm^2');
Writeln('Volume of the coil: ',DL*AD*1E6:10:5,' cm^3');
Writeln('weight of the coil: ',DL*AD*1E6*8.92:10:5,' Gramm'); {Dichte Cu: 8.92 g/cm^3}
Writeln('initial voltage of the capacitor:',UC:12:5,' Volt');
Writeln('total amount of time: ',N*dt,' sec. in ',N,' Schritten');
Writeln; Writeln('mechanical oscillation of the capacitor plates:');
Writeln('mass of the capacitor plates m= ',m*1000:10:5,' Gramm');
Writeln('frequency of the capacitor plates: fFol= ',fFol:10:7,' Hz. ');
Writeln('attractive formce of capacitor plates: Kraft F= ',F,' N');
Writeln('initial deflection of capacitor plates: F/D= ',F/D,' m');
Writeln('position of the unloaded capacitor plates: ',CD/2);
Writeln('position of the loaded capacitor plates: X[0]: ',X[0]);
Writeln('precision of the plates position, Differenzkraft: ',Fc+Fd,' N');
Writeln('initial plates position, part 3: ',SP3:10:7,' m');
Writeln('capacity of the of the unloaded capacitor: C= ',epo*epr*CA/CD,' Farad');
Writeln('capacity of the of the loaded capacitor: C[0]= ',epo*epr*CA/(2*x[0]),' Farad');
Writeln('enhancement of the capacity: ',epo*epr*CA*(1/2/x[0]-1/CD),' Farad');
Writeln('duration of computation: ',N*dt,' sec. ');
Writeln; {Wait;}

{ Begin of the algorithm.}
Writeln('1.part -> classical harmonic oscillation, without attenuation:');
Writeln(' t/[sec.] | Uc/[V] | ');
For i:=1 to N do
begin
UC:=Q[i-1]/C; UL:=-UC;
Qpp[i]:=UL/L;
Qp[i]:=Qp[i-1]+Qpp[i]*dt;
Q[i]:=Q[i-1]+Qp[i]*dt;
{ Writeln(i*dt:11:9,' | ',Q[i]/C:7:2,' | '); }
end;
If MacheFiles then Excel_Datenausgabe('Teil_01.dat'); Writeln;

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{-----}
Writeln('2.part -> classical harmonic oscillation, with Ohm's attenuation:');
Writeln(' t/[sec.] | Uc/[V] | '); { R:=2000; {enhanced resistance for testing}
For i:=1 to N do
begin
  Qpp[i]:=-1/L/C*Q[i-1]-R/2/L*Qp[i-1];
{ Qp[i]:=(Qp[i-1]+Qpp[i]*dt)/(1+R/L*dt); } {alternative simple approximation}
  Qp[i]:=Qp[i-1]+(Qpp[i]-R/2/L*Qp[i-1])*dt; {vgl. s=1/2*a*t^2}
  Q[i]:=Q[i-1]+Qp[i]*dt;
{ Writeln(i*dt:11:9,' | ',Q[i]/C:7:2,' | '); }
end;
If MacheFiles then Excel_Datenausgabe('Teil_02.dat'); Writeln;
{-----}

Writeln('3.part -> oscillation with zero-point-energy conversion');
{ Writeln(' t/[sec.] | x/[m] | Q[i]'); }
x[0]:=SP3; {mechanical starting position of the capacitor plates}
For i:=1 to N do
begin
  Fd:=-D*(x[i-1]-CD/2); {spring force}
  Fc:=-Q[0]*Q[0]/4/pi/epo/(2*x[i-1])/(2*x[i-1]); {Coulomb- force}
  xpp[i]:=(Fc+Fd)/m; {acceleration}
  xp[i]:=xp[i-1]+xpp[i]*dt;
  x[i]:=x[i-1]+xp[i]*dt;
  If x[i]<=1e-10 then
  begin
    Writeln (,'Capacitor plates touch each other. Coulomb-force too strong. STOP. ');
    Wait; Wait; Halt;
  end;
  C:=epo*epr*CA/(2*x[i]);
  Qpp[i]:=-1/L/C*Q[i-1]-(R+Rlast)/2/L*Qp[i-1];
  Qp[i]:=Qp[i-1]+(Qpp[i]-(R+Rlast)/2/L*Qp[i-1])*dt;
  Q[i]:=Q[i-1]+Qp[i]*dt;
{ Writeln(i*dt:11:9,' | ',x[i], ' | ',Q[i]); }
end;
If MacheFiles then Excel_andere_Ausgabe('Teil_03.dat'); Writeln;
Amplituden_anzeigen;
Leistung_berechnen;
{-----}

Wait; Wait;
End.

```