UTILIZATION OF SOFTWARE SUPPORT IN EDUCATIONAL PROCESS

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Abstract

Effectiveness of educational process can be increased by the application of some modern forms of teaching. One of them is implementation of information and communication technologies into teaching and utilization of inter-subject relations. The paper deals with the possibility of utilization of software support at innovative approach to the solution of the physical problem from electronics.

Key words: information and communication technologies, RLC series circuit, differential equation, MATLAB, Mathematica.

VYUŽITIE SOFTVÉROVEJ PODPORY V EDUKAČNOM PROCESE

Resumé

Efektívnosť vyučovacieho procesu je možné zvýšiť aplikáciou niektorých moderných foriem vyučovania. Jednou z nich je aj implementácia informačno-komunikačných technológií do výučby a využívanie medzipredmetových vzťahov. Príspevok sa zaoberá možnosťou využitia softvérovej podpory v inovatívnom prístupe k riešeniu úlohy z elektroniky.

Kľúčové slová: informačno-komunikačné technológie, sériový RLC obvod, diferenciálna rovnica, MATLAB, Mathematica.

Introduction

Mathematical and physical basis is a necessary condition for successful management of modern technical disciplines. In general disinterest in mathematics and physics along with the extent reduction of teaching these subjects at primary and secondary schools is proved by worse preparedness of secondary school graduates for the studies of natural sciences and technical disciplines and lower motivation to study technical study programs at technical universities. One of the forms to increase the interest in studies of natural sciences subjects is also application and utilization of innovative teaching forms, mainly introduction and utilization of information and communication and software tools into teaching. Information and communication technologies provide incomparably bigger information basics as it was several years ago. This gradually changes the style of teaching and makes teachers implement new technologies not only in real pedagogical action, but also at its preparation. By convenient combination of traditional and modern teaching methods we can stimulate interest of students in natural sciences studies, create conditions for the individualization of education and improve conditions for increasing the quality of education. Development of computer technique introduces many possibilities of utilization of software support at educational process. The following part of the paper presents the possibility of utilization of software environment at the problem solution from electronics.

1 RLC Series Circuit

Suitability of utilization of software environment is presented at the problem solution from electronics, specifically at the solution of differential equation of second order and depicting time dependence of the current and voltage of the RLC series circuit.

Problem: Calculate and draw the current and voltage in the capacitor of the RLC series circuit with $R = 5\,\Omega$, $L = 1\,mH$, $C = 1\,\mu F$ at the voltage connection $u = 10\,V$, if switched capacitor voltage was $0V$ and the current in the circuit at the switch in the circuit was equal to zero.

Solution: There is an electric circuit with the series switched components R, L, C connected to harmonic voltage with the initial conditions $i(t = 0s) = 0,\ \ u_C(t = 0s) = 0$ (Fig. 1).

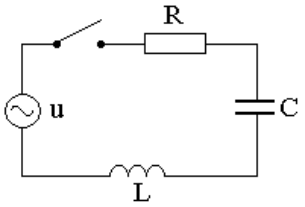


Fig. 1: RLC Series Circuit

Using Kirchhoff's voltage law for a closed loop it can be expressed as

$$u_L + u_C + u_R = u \tag{1}$$

where for momentary values we have

$$u_L = L\frac{di}{dt},\ \ u_C = \frac{1}{C}\int_0^t i dt,\ \ u_R = Ri \tag{2}$$

Substituting patterns (2) into the equation (1) for u_L, u_C, u_R, we have

$$L\frac{di}{dt} + \frac{1}{C}\int_0^t i dt + Ri = u \tag{3}$$

As current through a capacitor is $i = C\frac{du_c}{dt}$, substituting into the equation (3) we have

$$L\frac{d}{dt}\left(C\frac{du_C}{dt}\right) + \frac{1}{C}\int_0^t C\frac{du_C}{dt}dt + RC\frac{du_C}{dt} = u$$

$$LC\frac{d^2u_C}{dt^2} + RC\frac{du_C}{dt} + u_C = u \tag{4}$$

The equation (4) is a linear differential equation of second order with constant coefficients with the right side, which general solution is the sum of general solution of the appropriate equation without the right side and optional particular solution. As it can be seen from the equation, analytic problem solution is demanding and requires knowledge of the theory of solving differential equations as well as considerable mathematical skills. It is much easier to solve the problem by utilization and application of the software tools (i.e. MATLAB, Mathematica).

2 The problem solution by means of the MATLAB

It is necessary to realize at the solution of differential equations of higher order in MATLAB that every differential equation of higher order can be transposed to the

equivalent set of differential equations of first order with known initial conditions. At the problem solution it is suitable to transpose the differential equation of second order (4) to the set of differential equations of first order (5) as follows:

$$\frac{du_C}{dt} = \frac{i}{C}, \frac{di}{dt} = \frac{u - u_C - R.i}{L} \tag{5}$$

Basic standard function for the solution of differential equations is *ode45* function, which syntax is:

[*t*,*y*] = *ode*45 (´*name of the_function*´, *time_interval, initial_conditions*)

where *name of the_function* is reference to the function describing the set of differential equations, the parameter of *time_interval* is presented by the vector with two elements – initial time of solution t_0 and final time of solution t, the parameter of *initial_conditions* is presented by the vector of initial conditions y_0 from which we find $y(t_0) = y_0$. Two parameters are the output of the *ode45* function: t - the vector that contains instants of time, in which solution values are determined and y - the matrix containing its own solutions. To depict the current and voltage dependence on time, program writing in MATLAB is used, where the initial problem parameters, time and properties of depicted voltage and current dependences are given. The result of the program initialization is depiction of time dependence of the voltage and current of the RLC series circuit (Fig. 2):

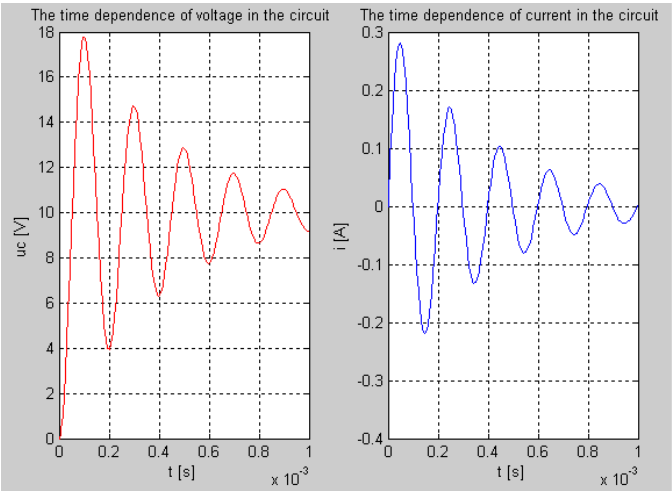


Fig. 2: Voltage and current flow in the RLC circuit

3 The problem solution in Mathematica program

Mathematica is a computational software program used in scientific, engineering, and mathematical fields and other areas of technical computing, which we use to solve the problem. The parameters of the problem are substituted into the equation (4) and equation is written into the Mathematica program as $(10\text{^}-9)(d(du/dt)/dt) + (5*10\text{^}-6)(du/dt) + u = 10$.

After the program initialization we have the solution for voltage:

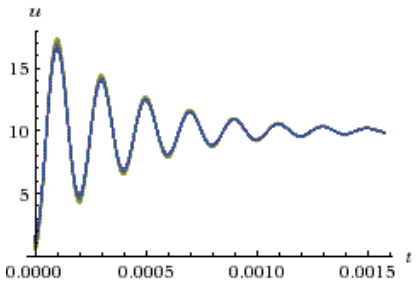
$$u_C(t) = C_1 e^{-2500t} \cos\left(2500\sqrt{159}t\right) + C_2 e^{-2500t} \sin\left(2500\sqrt{159}t\right) + 10 \tag{6}$$

where the solution of the equation is the sum of general solution of the appropriate equation without the right side u_c and optional particular solution u_P, t. j. $u_C(t) = u_c + u_P$. The C_1, C_2

constants are determined on the basis of the initial conditions. The result of the solution of our differential equation is

$$u_C(t) = -10e^{-2500t}\cos\left(2500\sqrt{159}t\right) - \frac{10}{\sqrt{159}}e^{-2500t}\sin\left(2500\sqrt{159}t\right) + 10 \tag{7}$$

The graph of voltage dependence can be found in Fig. 3a:



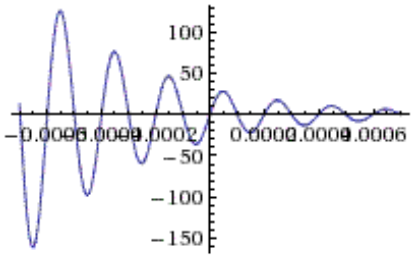


Fig. 3a: Voltage characteristics of RLC circuit

Fig. 3b: Current dependence of RLC circuit

For the current we have:

$$i(t) = C\frac{du_C}{dt} = \frac{400e^{-2500t}\sin\left(2500\sqrt{159}t\right)}{\sqrt{159}} \tag{8}$$

The equation (8) is written into the Mathematica program as follows: $400*(e\text{^}\text{-}(2500*t))*\sin(2500*sqrt(159)*t)/sqrt(159) = i$. The graph of current dependence can be found in Fig. 3b.

Conclusion

As it was mentioned before, analytic solution of the problem requires considerable mathematical skills and knowledge of the theory of solving differential equations. In the effort to simplify solution of the problems from electronics the software tools such as MATLAB and Mathematica can be used as one of the forms to increase the interest in studies of natural sciences subjects.

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Literature

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