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A study of applications of Differential Equations to array of fields

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Abstract: *Differential equations have a wide application in the field of electrical engineering, mechanical engineering, business, Biotechnology ,medical field ,economics, automobile, computer science etc. Differential equations are categorized as ordinary differential equations and partial differential equations. The distinction being that ODEs involve unknown functions of one independent variable while PDEs involve unknown functions of more than one independent variable.(1).In this paper we are going to focus on those type of differential equations used in various fields.*
Keywords*: Differential equation - D.E, Gross Domestic Product – G.D.P, ordinary differential equation-O.D.E Partial differential equation-P.D.E*

I. Introduction

D.E is a mathematical equation which contains derivatives, where derivatives represent rate of change and the equation defines a relationship between the two. It is a mathematical equation for an unknown function of one or several variables that relates the values of the function itself and its derivatives of various orders "to a particular phenomenon.(1) .For simplicity we can say a differential equation is an equation which involves derivatives of a function. The order of the equation is the highest derivative in the equation. There are many types of differential equations like O.D.E, P.D.E and non-linear differential equations. If we know general solution of homogeneous, we can solve non-homogeneous O.D.E.

Solution of a differential equation is finding an equation free from derivatives which satisfies the given D.E.

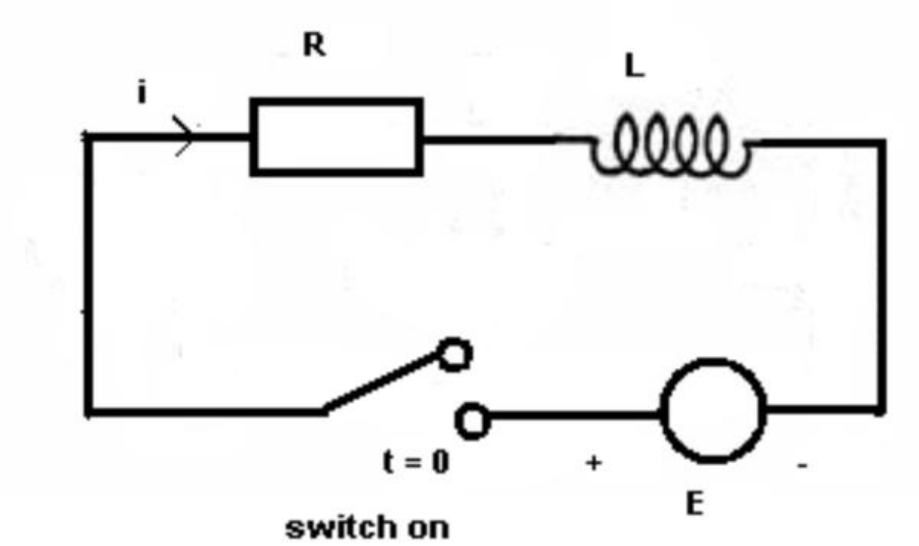
II. Applications of Differential Equation

In the field of Business, if P is the principal amount and r is the rate of interest, then the differential equation relating to the time t, P and r is

$$\frac{dP}{dt} = rP$$

In the field of Economics, differential equation expresses the rate of change of the current state as a function of the current state. A simple illustration of this type of dependence is changes of the Gross Domestic Product (GDP) over time. Consider state x of the GDP of the economy. The rate of change of the GDP is proportional to the current GDP $\frac{dx}{dt} = gx(t)$, where t stands for time and $\frac{dx}{dt}$ the derivative of the function x with respect to t . The growth rate of the GDP is $\frac{\frac{dx}{dt}}{x}$. If the growth rate g is given at any time t, the GDP at t is given by solving the differential equation. The solution is $x(t) = x(0)e^{gt}$.(2)

In the field of Electrical Engineering, differential equations are used to find current i at a given instant of time t. For example, in a circuit containing inductance L, resistance R, and voltage E, the current i is given by $L\frac{di}{dt} + Ri = E$. After solving this differential equation we get this expression of current $i = \frac{E}{R} - \frac{E}{R}e^{\frac{-R}{L}t}$



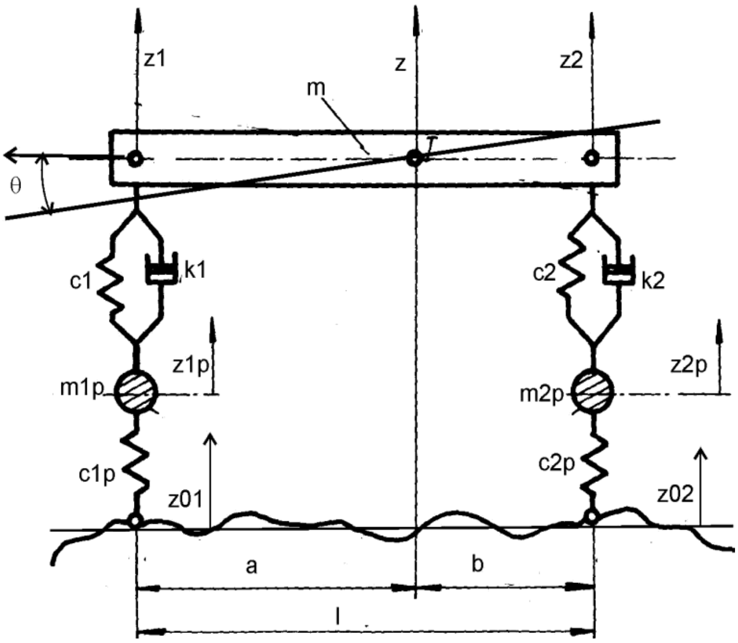
Circuit

In the field of Mechanical Engineering, the differential equation of a body falling from rest subjected to the force of gravity and air resistance is given by $v\frac{dv}{dx} + \frac{n^2}{g}v^2 = g.$ after solving this differential equation we get this expression of velocity $v^2 = \frac{g^2}{n^2}\left(1 - e^{\frac{-2n^2}{g}x}\right)$

In the field of Medical Science, Differential Equation deals with many real life problems selected from clinical cancer therapy, communication technology, polymer production, and pharmaceutical drug design. Partial differential equation (PDE) models are using in medicine, for example: cancer therapy hyperthermia and high frequency electrical engineering, for example: radio wave absorption. Reliability is the most important factor in medicine, because it is a nice parallelism with the intentions of mathematics. In other words, the situation requires and deserves the construction of highly efficient algorithms. (3)

In the field of Computer Science, Differential equation is widely used in game development. For example, a Video game involves jumping motion, a differential equation is used to check the velocity of a character when the command is given to return them to the ground in a simulated gravitational field.

In the field of Automobile, we use system of differential equations for the model of breaking vehicle. In dynamics of motor vehicles it is common that dominant vehicle motions are mutual separated and that the straight motion of a vehicle with certain problems are observed. To analyze stability of braked vehicle, the braked vehicle model was observed as presented in the following figure where effect of rigidity of front and rear wheel is observed and uneven road are monitored. (4)



Mathematical model of braking vehicle

Appropriate system of differential equations is

$$m\ddot{x} = F_x$$

$$m\ddot{z} + k_1(\dot{z}_1 - \dot{z}_{1p}) + c_1(z_1 - z_{1p}) + k_2(\dot{z}_2 - \dot{z}_{2p}) + c_2(z_2 - z_{2p}) = F_z$$

$$I_y\ddot{\theta} + a[k_1(\dot{z}_1 - \dot{z}_{1p}) + c_1(z_1 - z_{1p})] - b[k_2(\dot{z}_2 - \dot{z}_{2p}) + c_2(z_2 - z_{2p})] = F_\theta$$

$$m_{1p}\ddot{z}_{1p} - k_1(\dot{z}_1 - \dot{z}_{1p}) - c_1(z_1 - z_{1p}) + c_{1p}(z_{1p} - z_{01}) = 0$$

$$m_{2p}\ddot{z}_{2p} - k_2(\dot{z}_2 - \dot{z}_{2p}) - c_2(z_2 - z_{2p}) + c_{2p}(z_{2p} - z_{02}) = 0$$

Where

$F_x[N]$ - total longitudinal force
$F_z[N]$ - total vertical force
$z_1[m]$ - displacement of abut mass on front axle
$z_2[m]$ - displacement of abut mass on rear axle
$z_{1p}[m]$ - displacement of front wheel center
$z_{2p}[m]$ - displacement of rear wheel center
$m[kg]$ - vehicle abut mass
$m_{1p}[kg]$ - non abut mass on front axle
$m_{2p}[kg]$ - non abut mass on rear axle
$C_1[N/m]$ - characteristics of front suspension rigidity
$C_2[N/m]$ - characteristics of rear suspension rigidity
$C_{1p}[N/m]$ - characteristics of front wheel rigidity
$C_{2p}[N/m]$ - characteristics of rear wheel rigidity
$\theta[rad]$ - rotation angle of vehicle center around cross axle
$a[m]$ - distance of vehicle center from front axle
$b[m]$ - distance of vehicle center from rear axle

III. Conclusion

In this paper we have surveyed about applications of differential equations in various fields. Regarding automobile, it is the theoretical approach which considers all relevant quantities for braking vehicle, which gives effects of concepts for front and rear suspension system on the longitudinal vehicle stability.

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