The Taylor’s Polynomial Apply to Studies of Physics

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Abstract. The tool of studies of physical is produce by the theory of mathematics in general; it can make a relation of equation between physical quantities and other physical quantities, so the mathematics is importance in studies of physics.

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Introduction
Studies of physics is based on mathematics, the math tool is talisman in studies of physics. Taylor’s polynomial is apply to studies the kind of physical quantities that by proportion of two variables decision in physical. For example, the velocity, the acceleration, the current and so on. Taylor’s polynomial Not only it applicable in mechanics, but also it can applicable in thermodynamics and electricity.

1. Taylor’s Polynomial of General
In the studies of physical can used the derivative for function of several variables in general situation that is more complex than derivative for function of single variable. For example, a function of polynomial:

\[ f(x) = \sum_{i,j=1}^{n} (a_i b_j) \]

(1.1)

This is a polynomial that is high order, if the two quantities of a and b is variables, so the figure of function is very complex. But it can use methods of fitting in this function of polynomial that is represent the vary of the function. Due to the derivative is can represent the rate of vary of any quantities which is continues [1]:

\[ f(x) = \frac{\partial^n f(a)}{\partial a^n} \sum_{j=1}^{n} b_j + \frac{\partial^n f(a)}{\partial b^n} \sum_{i=1}^{n} a_i \]

\[ \cdot \left[ d^i + n d^{i-1} + \frac{1}{2} n(n-1) d^{i-2} + \frac{1}{3} n(n-1)(n-2) d^{i-3} + \ldots + \frac{1}{n!} \prod_{j=0}^{n-1} d_j \sum_{j=1}^{n} b_j \right] \]

(1.2)

\[ + \left[ b^j + n b^{j-1} + \frac{1}{2} n(n-1) b^{j-2} + \frac{1}{3} n(n-1)(n-2) b^{j-3} + \ldots + \frac{1}{n!} \prod_{j=0}^{n-1} b_j \sum_{j=1}^{n} a_i \right] + R(x) \]
This is a approximate for (1.1) it similar to Taylor’s polynomial in function of single variable. It is consist of two parts: $\frac{\partial g^{(n)}(x)}{\partial (a')^n}$ and $\frac{\partial g^{(n)}(x)}{\partial (b')^n}$, its sum should to approximate for the function. This kind of polynomial approximate for high order polynomial, this is Taylor polynomial of general.

Change a form for (1.2):

$$f(x) = \sum_{i=1}^{n} \frac{n!}{\partial (a')^n} \sum_{i=1}^{n} b^n_{i} + \sum_{i=1}^{n} \frac{n!}{\partial (b')^n} \sum_{i=1}^{n} a^n_{i} + R(x)$$ (1.3)

Our discover, this formula is same as essence of Taylor’s polynomial in function of single variable. According to (1.3), it had the Law of lagrange in high order polynomial [2]:

$$R(x) = \frac{\partial^{n+1} f(x)}{(n+1)!} \left( ab - \sum_{i=2}^{n} \sum_{j=2}^{n} (a'b') \right)$$ (1.4)

For the sum of two term there are variable, Had the Taylor’s polynomial of general:

$$(a\pm b)(x) = f(a\pm b) + \frac{\partial f(a\pm b)}{\partial a} b + \frac{1}{2!} \frac{\partial^2 f(a\pm b)}{\partial a^2} b^2 + \frac{1}{3!} \frac{\partial^3 f(a\pm b)}{\partial a^3} b^3 + \cdots + \frac{\partial^n f(a\pm b)}{\partial a^n} b^n + \frac{\partial^{n+1} f(a\pm b)}{(n+1)!} b^{n+1}$$

$$\left( a\pm b \right) = \frac{\partial^{n+1} f(a\pm b)}{(n+1)!} \left( ab - \sum_{i=1}^{n} \sum_{j=1}^{n} (a'b') \right)$$ (1.5)

2. Taylor’s Polynomial in Mechanics

In fact, any motion had the resistance, it makes increased the conditions of constraint for the motion, the resistance can produce by acceleration. According to Newton’s second law, the resistance is to be representative as [3]:

$$f_{(r)} = ma_{(r)}$$ (2.1)

So the (2.5) is change as [4]:

$$\left( a - a_{(r)} \right) t = 2f(a - a_{(r)}) + \frac{1}{2!} \frac{\partial^2 f(a - a_{(r)})}{\partial a^2} (a - a_{(r)})^2 + \frac{1}{3!} \frac{\partial^3 f(a - a_{(r)})}{\partial a^3} (a - a_{(r)})^3 + \cdots + \frac{\partial^n f(a - a_{(r)})}{(n+1)!} (a - a_{(r)})^{n+1}$$

$$\left( a - a_{(r)} \right) t = \sum_{i=1}^{n} \frac{1}{n!} \frac{\partial^n f(a - a_{(r)})}{\partial a^n} (a - a_{(r)})^n + \sum_{i=1}^{n} \frac{1}{n!} \frac{\partial^n f(a - a_{(r)})}{\partial a^n} (a - a_{(r)})^n + \cdots + \frac{\partial^n f(a - a_{(r)})}{(n+1)!} (a - a_{(r)})^{n+1}$$ (2.2)

For a object who had the ideal state of motion [5], the inertia force is reaction force for power. According to the essence of inertia force [6], the power is the virtual force too. For a kind of motion who’s velocity is variable, they are non-equivalent, so that, the gravitational mass is non-equivalent to inertial mass. In general, its obey to the relation:

$$m_{(i)} < m_{(l)}$$ (2.3)
For the variable velocity motion, the power is variable too. So the power can working at any moment and that is variable. According to the principle of virtual work, the sum of virtual work is non-zero:

$$\delta W_{\text{sum}} = \sum f \delta r = \sum m_i a_i \delta r \neq 0 \quad (2.4)$$

According to the relation of work and energy, exist virtual energy, it bloke the motion. It same to the potential energy in essence ang which is orign to inertial force. it obey to the acceleration:

$$\delta E = \sum_{i=1}^{n} \frac{1}{n!} \frac{d^n v_i}{dt^n} + \frac{1}{(n+1)!} \frac{d^{n+1} v_i}{dt^{n+1}} \delta r \quad (2.5)$$

According to Newton’s second law, the inertial mass as increase as reduce of acceleration. The acceleration representative the vary of kinetic energy, so the inertial mass is representative the potential energy. According to the (2.5), the inertial mass is proportional to the virtual energy, and it obeys to [7]:

$$\delta E = \delta W = m_i a_i \delta r \quad (2.6)$$

3. Taylor’s Polynomial Application in Electromagnetism

Actually, the variable of current had conditions of constraint that is resistance. For the variable of high order of resistance, it obeys to a law:

$$(R_{out} - R_{in})^n = \frac{\partial^n E}{\partial (I_{out} - I_{in})} \quad (3.1)$$

The sum of conditions of constraint is the consunption of resistance in unit time, so:

$$\sum_{i=1}^{n} (R_{out} - R_{in}) = \sum_{i=1}^{n} \frac{\partial^n E}{\partial (I_{out} - I_{in})} \quad (3.2)$$

Suppose had virtual electronic in internal circuit, that diriction of motion is inverse to positive electric and it formation of virtual current who is block the current, that is origin of resistance. It obeys to law:

$$E = (I_{out} - I_{in})(R_{out} - R_{in}) \quad (3.3)$$

Actually, exist the electrical field of dynamic that can produce to magnetic field. According to Maxwell’s equations, the electrical field and magnetic field is two kinds of state for same substance [8]:

$$\begin{align*}
\nabla \times E &= -\frac{\partial B}{\partial t} \\
\nabla \times H &= j + \frac{\partial D}{\partial t} \\
\nabla \cdot B &= 0 \\
\nabla \cdot D &= \rho
\end{align*} \quad (3.4)$$

The magnetic field of static that produces to electric field of dynamic but the direction of magnetic field is inverse with electric field, but it is static. It is due to the first derivative is zero, but the magnetic field is variable if the twice order derivative is non-zero, at the time, the electromagnetic field had vary of high order:

$$\begin{align*}
\nabla^n \times E &= -\frac{\partial^n B}{\partial t^n} \\
\nabla^n \times H &= j + \frac{\partial^n D}{\partial t^n} \\
\nabla^n \cdot B &= L^i \frac{\partial^n F}{\partial t^n} \\
\nabla^n \cdot D &= \rho
\end{align*} \quad (3.5)$$
According to (3.4) and (3.5), the magnetic field is variable if the current has high order variables

4. Taylor’s Polynomial Application in Thermodynamics

For a container in thermodynamics that is stable, the capacity is a constant:

\[ Q = cm\Delta t \Rightarrow c = \frac{Q}{m\Delta t} \quad (4.1) \]

If the container in thermodynamics which is variable, (4.1) is no longer right. For a kind of variable container that variable is uniform and it in a unit of mass [9]:

\[ dC = \lim_{t\to 0} \frac{dQ}{dt} \quad (4.2) \]

For the container who has high order variable, the capacity for thermal is very complex. According to Taylor’s polynomial in single variable:

\[ dC = \lim_{t\to 0} \left( \frac{dQ}{dt} + \frac{1}{2!} \frac{d^2Q}{dt^2} + \cdots \right) + \frac{c^{(n)}(Q)}{(n+1)!} Q^n \quad (4.3) \]

Actually, the distribution of mass as vary as temperature in some situations. For example, the distribution of mass of Cepheid variable stars as temperature as vary. Because of the photometric is proportional with temperature, so the photometric is proportional with mass that is a kind of approximate, it obeys to:

\[ C = \frac{\partial Q}{\partial m\Delta t}(Q-Q_0) + \frac{1}{2!} \frac{\partial^2 Q}{\partial m^2 \Delta t^2}(Q-Q_0)^2 + \cdots + \frac{\partial^{(n)}(Q)}{(n+1)!} (Q-Q_0)^{n+1} \quad (4.4) \]

The condition of this formula is the system had variable of temperature that is continuous. It was condition for increasing of pressure, so the pressure was a constant if the temperature was constant.

For Cepheid variable stars, the distribution of mass is depending on pressure at external of Cepheid variable stars [10]. The density of energy achieved the maximum when it volume is minimum [11], at the this time , the pressure makes the repulsive effect it between one atom and other atom , is makes the Cepheid variable stars start of inflation and reduce the temperature. Its temperature is lowest when the pressure at external equivalent to pressure at internal. At the time, the density of energy is uniform in Cepheid variable stars and that is minimum. According to (4.4) the temperature is lowest.

In fact, the gases had the compressibility factor [12]:

\[ Z = \frac{pV}{nRT} \quad (4.5) \]

For a adiabatic system, the temperature is constant, so the compressibility factor as vary as pressure at external or the volume of container:

\[ dZ = \frac{\partial p\partial V}{\partial T} = \frac{\partial p\partial V}{\partial T} \frac{\partial T}{\partial t} \quad (4.6) \]

According to (4.6) the temperature to be constraint the pressure at external and the volume of container.

5. Conclusion

All in all, the Taylor’s polynomial applicable to the process of physical that is continuous. For the function of several variables, the Taylor’s polynomial is apply too. The essence of Taylor’s polynomial is continuous derivative for a polynomial function and gets a constant.

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