

# Solution of Partial Differential Equation using MATLAB- A Better Alternative

Shekhar

Lovely professional university, phagwara, punjab, India

## Abstract

In this paper, we present solution of Partial Differential Equation with the use of MATLAB. We give detail about MATLAB and its modules, plotting the graphs of solution of Partial Differential Equations, also we try to solve and simulate the Partial Differential Equations using MATLAB. We will describe the process of Partial Differential and its solution in graphical format. Also we are plotting the results of all these Partial Differential Equations mentioned above, and thus compare and show that better results are obtained by MATLAB.

**Key words** - MATLAB, Partial differential equation, plotting the graphs, traditional paper pencil method.

## I. INTRODUCTION

### A. Differential Equation

An Equation involving derivatives of one or more dependent variable with respect to one or more independent variables is called Differential Equation.

### B. Partial Differential Equation

A Differential Equation involving Partial derivatives of one or more dependent variable with respect to more than one independent variable is called Partial Differential Equation.

## II. MATLAB (MATRIXLABORATORY)

MATLAB is a multi-paradigm numerical computing environment and property programming language developed by mathwork.

### A. Basic Equations

Partial Differential Equations are one of an important subjects and it is a foundation of many other aspects of applied science and engineering. It concerns with study of Differential Equations. From the early days of calculus, the Partial Differential Equation has been a great area of theoretical research and particular applications and it continues to be so in our days.

$$\frac{d}{dx}(e^{ax}) = ae^{ax} \quad (1.1.1)$$

$$\frac{d}{dx}(uv) = u \frac{dv}{dx} + v \frac{du}{dx} \quad (1.1.2)$$

### B. Partial Differential Equation

A Differential Equation involving Partial derivatives of one or more dependent variable with respect to more than one independent variable is called Partial Differential Equation. We will consider the case of two independent variable and one dependent variable, usually take x and y as independent variable and z as dependent variable.

**For example:-**

$$\frac{\partial z}{\partial x} + \frac{\partial z}{\partial y} = z + xy \quad (1.2.1)$$

### C. Order of Partial Differential Equation

The order of the highest Partial derivative is occurring in the Partial Differential Equation is called the order of a Partial Differential Equation.

#### D. Degree of Partial Differential Equation

The degree of Partial Differential Equation is the degree of highest order derivative which occurs in it after the Equation has been rationalized ,i.e., Made free from radicals and fractions as far as derivatives are concerned the Equation;

#### E. Solution of Partial Differential Equation

In this paper we re-investigate the problem of Partial Differential Equation with one dependent variable say z with respect to two independent variable say x and y. In the 1<sup>st</sup> method we attempt for Partial Differential Equation solution of the problem. In this method we are solving Partial Differential Equation by differentiating the dependent variable z partially with respect to x, y, xy, yx, xx, yy.

In the second method, we are trying to solve Partial Differential Equation using MATLAB. We are use MATLAB to calculate terms of series coefficients, which are compared with the manually calculated terms. Later invoke suitable expansion scheme for obtaining large number of terms in the perturbation solution.

Now we are trying to solve an example of Partial Differential Equation by a traditional paper pencil method as well as using MATLAB. Which are try to solving below:-

Solution of partial differential equation by traditional method of  $\sqrt{p}-\sqrt{q}+3x=0$

Example : we have to find the complete integral of  $\sqrt{p}-\sqrt{q}+3x=0$

Solution: the given partial differential equation is  $\sqrt{p}-\sqrt{q}+3x=0$

Or  $\sqrt{p}+3x = \sqrt{q} = a$  (say)

$\sqrt{p} = a-3x$  and  $\sqrt{q} = a$

Hence,  $p = (a - 3x)^2$  and  $q = a^2$

Substituting the value of p and q in  $dz = pdx + qdy$  , we get

$$dz = (a - 3x)^2 dx + a^2 dy \quad (2.5.2)$$

integrate (2.5.2) , we get

$$z = \frac{-(a-3x)^3}{9} + a^2 y + c$$

which is required complete integral.

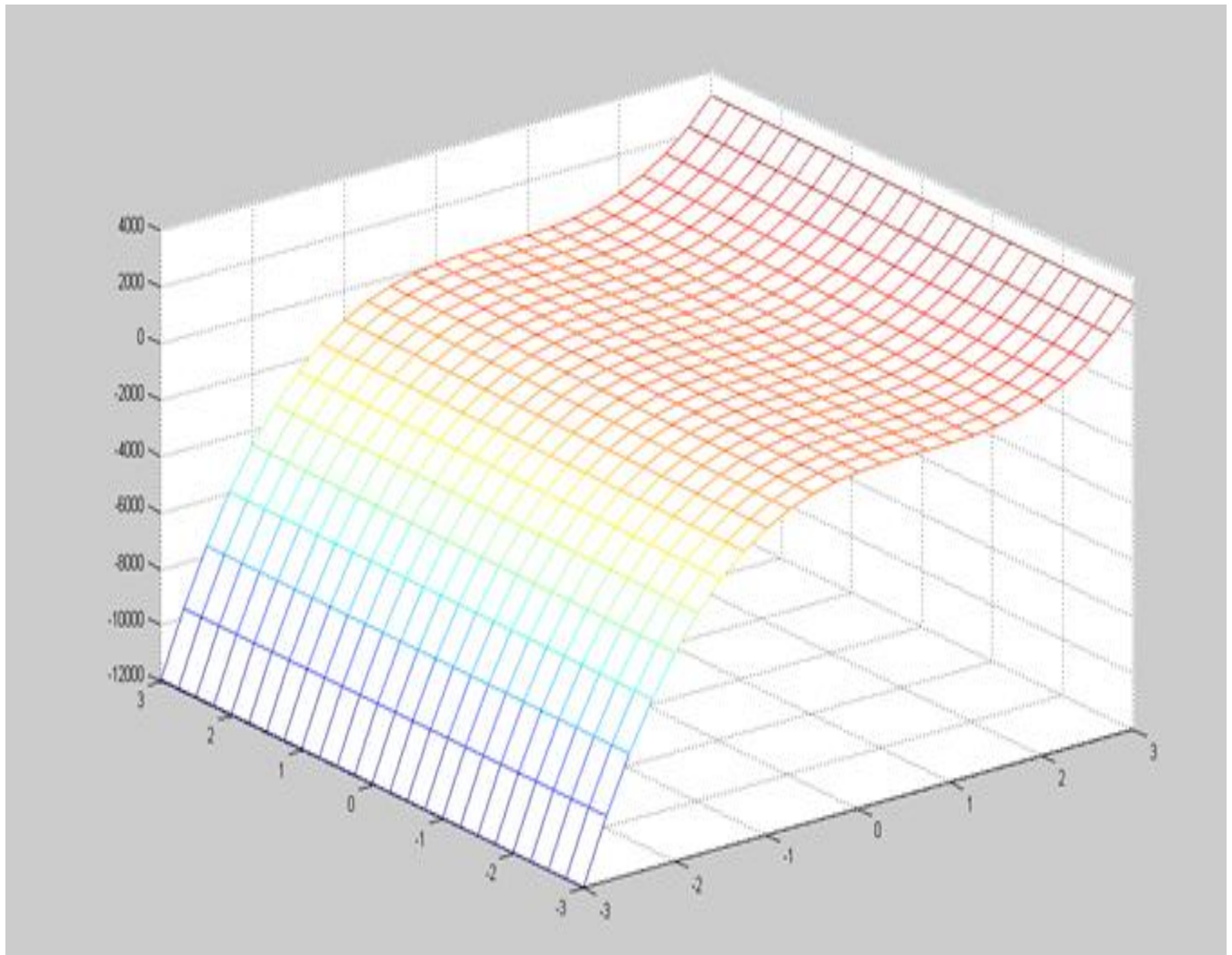
#### Graphical format of solution of above given Partial Differential Equation

##### Plotted Graph

```
>> x=-3:0.25:3;  
>> y=-3:0.25:3;  
>> [X, Y] = meshgrid(x, y);  
>> a=2;  
>> c=5;  
>> Z = -1/9 * (a-3*X).^3 + a.^2 * Y + c;  
>> mesh(X, Y, Z)  
>>
```

### Graphical format of solution of above given Partial Differential Equation

#### Plotted Graph



### III. SOLUTION OF PARTIAL DIFFERENTIAL EQUATION USING MATLAB

```
>> x= -3:0.25:3;  
>> y= -3:0.25:3;  
>> [X, Y] = meshgrid(x, y);  
>> a=2;  
>> c=3;  
>> Z= -1/9.*(a-3*X).^3+a.^2*Y+c;  
>> mesh(X,Y,Z);
```

```
>>xlabel( x);
```

```
>>ylabel(y);
```

```
>>zlabel(z)
```

Before solving any Partial Differential Equation using MATLAB, first of all we have to know the range of independent variable say  $x$  and  $y$ . Here we are take range of  $x$  and  $y$  is  $[-3, 3]$  we must converted  $x$  and  $y$  variable into  $X$  and  $Y$  matrix. By using the command

```
>>[X,Y] =meshgrid(x,y);
```

Now if we have some constant in Partial Differential Equation then we must assign some value to them. We convert dependent variable  $z$  into  $Z$  matrix by applying operation in  $z$  variable, after this we are plotting graph of Partial Differential Equation by using command.

```
>>mesh(X,Y,Z)
```

Now we are assigning boundary value by using the commands.

```
>>xlabel( x);
```

```
>>ylabel(y);
```

```
>>zlabel( x)
```

#### IV. CONCLUSION

The graph of the solution of the partial differential equation is plotted by the use of MATLAB. MATLAB gives us a very clear and good graph of the solution of the given partial differential equation that is  $z = \frac{-(a-3x)^3}{9} + a^2 y + c$ ; where  $\sqrt{q} = a$ , we are solving Partial Differential Equation by differentiating the dependent variable  $z$  partially with respect to  $x$ ,  $y$ ,  $xy$ ,  $yx$ ,  $xx$ ,  $yy$ .

In the second method, we are trying to solve Partial Differential Equation using MATLAB. We are use MATLAB to calculate terms of series coefficients, which are compared with the manually calculated terms. Later invoke suitable expansion scheme for obtaining large number of terms in the perturbation solution. And getting the good result.

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