S.K.R GOVERNMENT DEGREE COLLEGE GUDUR

SPSR NELLORE DISTRICT

A MINI STUDY PROJECT REPORT

DIFFERENTIAL EQUATIONS AND ITS APPLICATIONS

DEPARTMENT OF MATHEMATICS

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S.K.R GOVERNMENT DEGREE COLLEGE, GUDUR

DEPARTMENT OF MATHEMATICS

CERTIFICATE

This is to certify that the STUDYPROJECT entitled

DIFFERENTIAL EQUATIONS AND ITS APPLICATIONS

Is the bonafied work done

By

B.SUPRAJA of I B.SC(MPCS)

This work has been carried out under my guidance

Smt.S.Kiranmaiye
Lecturer & Incharge ,
Dept. of Mathematics
S.K.R Govt. Degree College,
GUDUR.Tirupati Dist.

Differential Equations

Introduction:- In Mathematics, a differential equation is an equation that contains one (or) more functions with its derivatives. The derivatives of the function define the rate of change of a function at a point. It is mainly used in fields such as physics, Engineering, Biology and soon. The primary purpose of the differential equation is the study of solutions that satisfy the equations and satisfy the properties of the solutions.

One of the easiest way to solve the differential equation is by using explict formulas.

Definition of Differential Equation:-

A differential equation is an equation which contains one (or) more terms and the derivative of one variable (i.e., dependent variable) with respect to the other variable (i.e., independent variable).

$$\frac{dy}{dx} = f(x)$$

Here, 'x' is an independent variable and 'y' is a dependent variable.

Ex:- $\frac{dy}{dx} = 5x.$

A differential equation contains derivatives which are either partial derivatives (or) ordinary derivatives. The derivative represents a rate of change, and the differential equation describes a relationship between the quantity is continuously varying with respect to the change in another quantity.

Order of Differential Equation:

The order of the differential equation is the order of the highest order derivative present in the equation. Here, some examples for different orders of the d.e are given.

$\Rightarrow \frac{dy}{dx} = 3x+2$, The order of the equation is 1.

$\Rightarrow \left(\frac{d^2y}{dx^2}\right)+2\left(\frac{dy}{dx}\right)+y=0$. The order is 2.

$\Rightarrow \left(\frac{dy}{dt}\right)+y = kt$. The order is 1.

First order Differential Equation:

It is the differential equation which has degree equal to 1. All the linear equations in the form of derivatives are in the first order. It has only the first derivative such as $\frac{dy}{dx}$, where 'x' and 'y' are two variables and is represented as:

$$\boxed{\frac{dy}{dx} = f(x,y) = y'}$$

Second - order differential Equation:-

The Second order derivative is the Second order differential equation. It is represented as :

$$\frac{d}{dx}\left(\frac{dy}{dx}\right) = \frac{d^2y}{dx^2} = f''(x) = y''$$

Degree of Differential Equation:-

The degree of the differential equation is the power of the highest order derivative, where the original equation is represented in the form of a polynomial equation in derivatives such as y', y'' and y''' and soon.

Suppose $\left(\frac{d^2y}{dx^2}\right)+2\left(\frac{dy}{dx}\right)+y=0$ is a differential equation, so the degree of this equation here is 1.

Some examples are:

⇒ $\frac{dy}{dx}+1=0$, degree is 1.

⇒ $(y''')^3 + 3y'' + 6y' - 12 = 0$ degree is 3.

⇒ $\left(\frac{dy}{dx}\right)+\cos\left(\frac{dy}{dx}\right)=0$; it is not a polynomial eqn. in y and the degree cannot be defined.

Note:- Order and degree (if defined) of a differential equation are always positive integers.

Types of Differential Equations :-

Differential equations can be divided into several types namely:

* Ordinary differential Equations.
* Partial differential Equations
* Linear differential Equations
* Non-linear differential Equations.
* Homogeneous differential Equations
* Non-homogeneous differential Equations

Differential Equations Solutions :-

A function that satisfies the given differential equation is called its solution. The solution that contains as many arbitary constants as the order of the differential equation is called a 'General Solution'. The solution free from arbitary constants is called a particular solution. There exists two methods to find the solution of a d.E

* Seperation of Variables

* Integrating factor.

Seperation of the Variable is done when the d.e can be written in the form of $\frac{dy}{dx} = f(y)g(x)$ where f is the function of y only and g is the function of x only. Taking an initial condition, rewrite this problem as $\frac{1}{F(y)}dy = g(x)dx$ and then integrate on both sides.

Integrating factor techniaue is used when the differential eaiuation is of the form $\frac{dy}{dx} + P(x)y = q(x)$ where p and q are both the functions of x only.

First order d.e is of the form $y' + P(x)y = Q(x)$. where P and Q are both functions of x and the first derivative of y. The higher order differential equation is an equation that contains derivatives of an unknown function which can be either a partial (or) ordinary derivative. It can be represented in any order.

Applications:-

Differential equations have several applications in different fields such as applied mathematics, Science and engineering. A part from the technical applications, they are also used in solving many real life problems.

Some differential equation applications in real-time are :-

* Differential equations describe various exponential growths and decays.
* They are also used to describe the change in return or investment over time.
* They are used in the field of medicine for modelling cancer growth (or) the spread of disease in the body.
* Movement of electricity can be described with the help of it.
* They help economists in finding optimum investment strategies.
* The motion of waves (or) a pendulum can also be described using it.

P. Venkatrao 22/09/22

Sri K. Govt. Degree College
GUDUR - 524 102.
Sri Potti Sreeramulu Nellore Dt