VIGNAN'S
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## Department of Civil Engineering

**I B.Tech**

**Index**

# Applications of ODE-Simple Harmonic Motions

## (FIELD PROJECT– *REPORT*)

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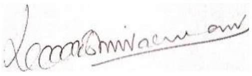
VADLAMUDI, GUNTUR- 522213, AP, INDIA.

March 2023

# CERTIFICATE

This is to certify that the project report titled "**APPLICATIONS OF CONES-EQUATION OF A CONE THOROUGH THE GIVEN VERTEX"** Submitted by NUKATOTI HANOKU (231FA03001)MOHIT KUMAR PAL (231FA0002) KATTA PRIYA (221FA03003) AKRAM AHMED (221FA03004) KHLIALI MOHAMED (221FA03005) is carried out as field project work under my supervision. I approve this field project work for submission towards partial fulfilment of the requirements and course work in prescribed for B.Sc., VFSTR (Deemed to be University).



Project Guide

Head of Department

**Abstract:** Many things in nature are periodic: the seasons of the year, the phases of the moon, the vibration of a violin string, and the beating of the human heart. In each of these cases, the events occur in repeated cycles, or periods. In this project, you will investigate the periodic motion of a spring, using a mini Slinky®. You can also measure the motion of your spring using Google's Science Journal app. Basic physics will then allow you to determine the Hooke's Law spring constant. Your analysis will also yield the effective mass of the spring, a factor that is important in real-world engineering applications.

## Introduction

### Objective

Periodic or oscillatory motion is common throughout the universe, from the smallest to the largest distance and time scales. This kind of motion is related to the forces acting between objects by Newton's 2nd law, just as all motions are. To have oscillatory motion, there must be a restoring force that acts in a direction to cause an object to return to its equilibrium position. A particularly common type of oscillatory motion results when the magnitude of the restoring force is directly proportional to the displacement of the object from equilibrium:

Frestoring=−kx(8.5.1)(8.5.1)Frestoring=−kx

This is the force law characteristic of a spring that is stretched or compressed from its equilibrium position. The oscillatory motion that results from this force law is known as ***simple harmonic motion*** (**SHM**).

Even when the force law is not as simple as Equation 8.5.18.5.1 for arbitrary values of xx, it turns out that for an object that oscillates about an equilibrium position, this linear law provides an accurate description for small oscillations. Thus, we can make a very strong statement:

essentially every system that vibrates, does so in **SHM** for small amplitudes of vibration.

Because it is so common, it is worth spending some effort understanding **SHM** and the different ways to represent it. Another reason for focusing on **SHM** is that periodic wave motion is the interconnected vibrations of many, many oscillators, each vibrating in **SHM**.

## Simple Harmonic Motion

Our approach is to use the tools we have at our disposal, namely, Newton's 2nd law, to analyze the motion of several different physical systems that exhibit oscillatory motion. We will look for common features of the motion and its description. Then, we will generalize the description and representation. In this process we will develop explicit mathematical expressions to represent the motion and we will see how properties of the motion such as the period of oscillation are related to the physical parameters of the particular phenomena. In this process we will revisit the energies involved in oscillating systems and gain a deeper understanding of the energy relationships.

## First System: Mass on a Spring

We consider a mass hanging on a spring. There are two forces acting on the mass: the pull upward of the spring and the gravity force of the Earth pulling down. We saw previously that if we take x to be the distance from the equilibrium position of the mass as it hangs motionless on the spring, then the net force has the form

$$\sum F=-kx(8.5.2)(8.5.2)\sum F=-kx$$

Now we apply Newton's 2nd law: net force equals mass times acceleration

$$-kx=ma,or(8.5.3)(8.5.3)-kx=ma,or$$

$$-kx=md2xdt2(8.5.4)(8.5.4)-kx=md2xdt2$$

This is called a differential equation, because it involves derivatives of x. A standard way to write this equation that will be useful as we compare different systems is

$$a=\frac{d^2}{dt^2}x(t)=-\frac{k}{m}x(t) \tag{8.5.5}$$

Let's note several things about this equation. Its solution will be a mathematical expression that gives the position x as a function of the time $t$. The equation says that if we differentiate this function twice, we get back the same function multiplied by the negative constant -***k/m*** (***k*** and ***m*** are both positive constants). Also, the acceleration,

$$a=\frac{d^2}{dt^2}x(t) \tag{8.5.6}$$

is not constant. Rather, the acceleration is proportional to the displacement from equilibrium, but with the opposite sign.

What kind of function, when differentiated twice, gives back the same function, but with a negative constant coefficient? Perhaps you remember from your calculus course which function has this property. If you do not, that is OK. What's important is to understand the properties of the solution, not how to get the solution. There are two functions that have the property we desire. One is the sine function and the other is the cosine function. The second derivative of $A\sin(bt)$ with respect to $t$ (when A and ***b*** are constants) is $-b^2A\sin(bt)$. That is,

$$\frac{d^2}{dt^2}A\sin bt=-Ab^2\sin bt \tag{8.5.7}$$

And similarly for the cosine function.

We compare Equation 8.5.7 to the equation for the mass on a spring,

$$\frac{d^2}{dt^2}x(t)=-\frac{k}{m}x(t) \tag{8.5.8}$$

we notice that they are the same if $b^2$ equals $k/m$. If we make that substitution, we get x(t)=Asin(kmt−−−√)(8.5.9)(8.5.9)x(t)=Asin(kmt)

differentiating twice with respect to t and see if you do not get the function x(t)x(t) back multiplied by the negative constant ***-k*/*m***.

These two functions (the sine and the cosine) are solutions of the differential equation we obtained by applying Newton's 2nd law to the mass hanging on the spring. These functions repeat every time the angle btbtincreases by 2π2π. Thus, the time to complete one oscillation is that value of tt that satisfies the relation bt=2πbt=2π. This time is called the **period** and is denoted by the letter TT. It is equal to 2π/b2π/b.

T=2πb=2πmk−−−√(8.5.10)(8.5.10)T=2πb=2πmk

Note that we know the period if we know the values of the factors that appear in Newton's 2nd law (mass and spring constant).

We can now write the differential equation in terms of TT.

d2dt2x(t)=−(2πT)2x(t)(8.5.11)(8.5.11)d2dt2x(t)=−(2πT)2x(t)

and the possible solutions also in terms of TT:

x(t)−Asin2πtT(8.5.12)(8.5.12)x(t)−Asin2πtT

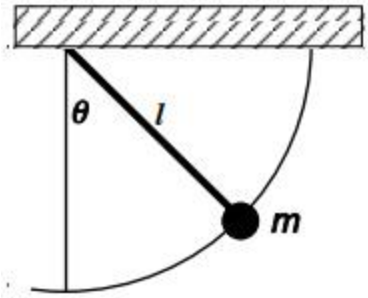
or

x(t)=Acos2πtT(8.5.13)(8.5.13)x(t)=Acos2πtT

Before pursuing the analysis of the spring mass system further, we will look at another system. Then we will generalize our results and discuss them in much more detail.

## Second System: Simple Pendulum

We consider a mass hanging on a lightweight string. The mass swings back and forth when pulled aside and released. How do we apply Newton's 2nd law?




We first identify the objects and all the forces acting on the objects. Then, the Net Force acting on any particular object is equal to the product of the mass and acceleration of that object. In the case of our pendulum, the object of interest is the bob. (In our model, the mass of the string is negligible.) Two forces act on the bob - the tension in the string directed along the string, and the gravitational pull of the earth straight down on the bob. The vector sum of these two forces is the net force or unbalanced force. The motion is constrained to be along the arc of a circle with radius equal to the length of the string, ***l***. The tangential component of the net force, that is, the force tangent to the path the bob takes, is the component that causes the bob to speed up or slow down along this path. (The component of the net force along the string causes the bob to move in a circle, and is dependent on the instantaneous speed. We do not need to be concerned with this radial force now.)

To proceed, we draw a force diagram (Figure 8.5.1), showing the forces acting on the bob. Applying Newton's 2nd law along the tangential direction gives

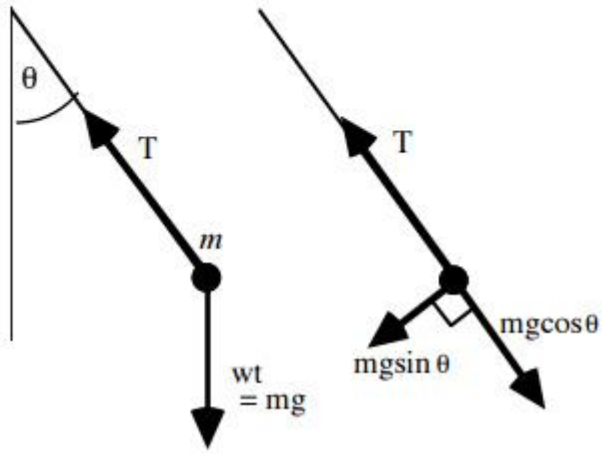



**Figure 8.5.1**

mgsinθ=−matangential(8.5.14)(8.5.14)mgsinθ=−matangential

The minus sign tells us that at angential is opposite to the direction of increasing θθ. It is useful to express atangentialatangential

in terms of θθ.Since a atangentialatangential is the second derivative of a distance moved along the arc, and since a distance along the arc is simply the product of lθlθ , atangential=ld2θ/dt2atangential=ld2θ/dt2. Then,

mgsinθ=−mld2θdt2(8.5.15)(8.5.15)mgsinθ=−mld2θdt2

and cancelling out the mass

gsinθ=−ld2θdt2(8.5.16)(8.5.16)gsinθ=−ld2θdt2

This looks almost like our equation of motion for a mass on a spring. The difference is we have a sinθsinθ in stead of θθ on the left hand side. Perhaps for small oscillations, that is small values of θθ, we can replace sinθsinθ with θθ.

If we make this approximation (substituting for sin and then group the constants together on the left hand side) we get:

−glθ=d2θdt2(8.5.17)(8.5.17)−glθ=d2θdt2

If we put this in standard form, we can easily compare it to the equation we got for the mass oscillating on a spring.

simplependulum:d2θdt2=−glθ(t)(8.5.18)(8.5.18)simplependulum:d2θ dt2=−glθ(t)

massonspring:a=d2xdt2=−kmx(t)(8.5.19)(8.5.19)massonspring:a=d2x dt2=−kmx(t)

The similarity in these two equations. Except for the name of the variable, θθ or xx, which is arbitrary, they have the identical form.

We saw before, that in terms of the period to make a complete oscillation, we could write the expression for x(t)x(t) as:

d2dt2x(t)=−(2πT)2x(t),where(8.5.20)(8.5.20)d2dt2x(t)=−(2πT)2x(t),where

(2πT)2=km←T=2πmk−−−√(8.5.21)(8.5.21)(2πT)2=km←T=2πmk

Now by comparing the pendulum equation to the mass and spring equation, we see that the relation giving the period for a pendulum must be:

(2πT)2=gl←T=2πlg−−√(8.5.22)(8.5.22)(2πT)2=gl←T=2πlg

Also, since the equation for the mass on a spring and the equation for the pendulum are in fact the same equation with different constants, they must have the same solution. So the mathematical function that worked for the mass-spring, must work for the simple pendulum, too. The distinguishing feature that makes these equations similar is that the acceleration is proportional to the displacement, but with the opposite sign. This is the unique feature that leads to simple harmonic motion (SHM).

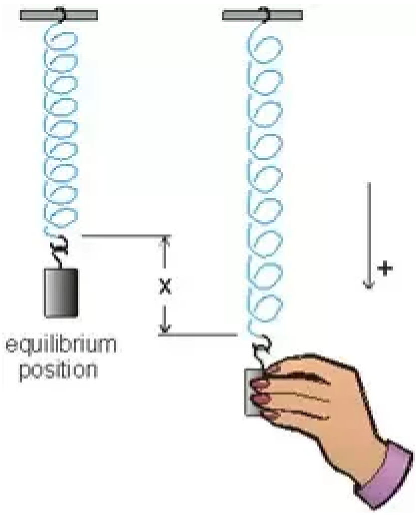
Before going any further with the analysis of SHM, it is useful to investigate its general properties. This is what we will now do.

I am not sure if this is more of a maths problem than a physics if so could admin place in the math stack.

So my question is as follows. I have recently been looking at SHM in a spring-mass, as shown by the picture

Limitations of Simple Harmonic motions:

1. Motion of a body attached to the end of an elastic spring.




and it got me thinking about the equation of motion of SHM the conditions needed for SHM to occur specifically the maximum and minimum value of displacement.

What I mean but maximum and minimum values are like so. A condition for SHM is that the acceleration of the object is

**Conclusion:**

ODEs are the cornerstone of understanding and analyzing simple harmonic motion (SHM). They empower us to predict and analyze the behavior of oscillating systems, revealing their position, velocity, frequency, period, and amplitude. This capability allows us to model real-world phenomena like vibrating molecules, AC circuits, and even the classic mass-spring system. Furthermore, ODEs can be modified to incorporate the effects of damping and external forces, enabling us to study their impact on the oscillation, making them an invaluable tool across various scientific and engineering disciplines.

( FIELD PROJECT– *REPORT*)

# TO PROVE COMPLETE CONJUNCTIVE NORMAL FORM AS '0'AND CONVERT CCNF TO CDNF

***Submitted by***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(ACCREDITED BY NAAC WITH "A$^{++}$ " GRADE)

VADLAMUDI, GUNTUR- 522213, AP, INDIA

March 2023

# **CERTIFICATE**

This is to certify that the project report titled "TO PROVE COMPLETE CONJUNCTIVE NORMAL FORM AS '0'AND CONVERT CCNF TO CDNF**"** Submitted by **BISHALSHRESTHA-(221FA03005) NISHCHAAC KAFLE-(221FA0403008) RUPESHRAY YADAV-(221FA03009)** is carried out as field project work under my supervision. I approve this field project work for submission towards partial fulfilment of the requirements and course work in prescribed for B.Sc., VFSTR (Deemed to be University).

Project Guide

Head of Department

## ABSTRACT:-

we are going to prove complete conjunctive normal form as '0', and complete disjunctive normal form, as '1'. And drawing the truth table for the both ccnf and cdnf.

To proving them we are using distributive law also.


## INTRODUCTION:-

### What is conjunctive normal form?

Ans:- The Boolean function is expressed as product of max terms then it is called cnf.

Expression:- f(x,y,z)=.(x+y+z).($x^|$+$y^|$+z).(x+y+$z^|$)

### What is complete conjunctive normal form?

Ans:- The Boolean function is expressed is expressed as product of all $2^n$ max terms of 'n' variables then it is called complete conjunctive normal form

EXPRESSION:-

F(x, y, z) = (x + y + z)•(x'+ y'+ z) •

(x'+ y + z') • (x'+ y + z)•(x + y + z) •

(x' + y + z) • (x + y'+ z) • (x'+ y'+z')

### What is disjunctive normal form?

ANS:- the Boolean expression is expressed as sum of the min terms (or) products terms is called dnf.

EXPRESSION:- f(x,y)=xyz+$x^|$+$y^|$+z+$x^|$+$y^|$+$z^|$

### What is complete disjunctive normal form?

ANS:- the Boolean expression is expressed s sum of all $2^n$ min term of 'n' variable is called cdnf.

Expression:- F(x,y,z)= (x+y+z).(x+y+$z^|$).(x+$y^|$+z).(x+$y^|$+$z^|$).

($x^|$+y+z).($x^|$+y+$z^|$).($x^|$+$y^|$+z).($x^|$+$y^|$+$z^|$)

Proof of ccnf:-

Given three variables are x,y,z

f(x,y,z) so for ccnf we want write in $2^n$

They given 3 variables x,y,z so $2^3$ =8

So expression in ccnf is

F(x,y,z)=(x+y+z).(x+y+$z^|$).(x+$y^|$+z).

(x+$y^|$+$z^|$).($x^|$+y+z).($x^|$+y+$z^|$).

($x^|$+$y^|$+z).($x^|$+$y^|$+$z^|$

So this is 8 expressions now we want prove the expression is zero

F(x,y,z)= (x+y+z).(x+y+$z^|$).(x+$y^|$+z).(x+$y^|$+$z^|$).($x^|$+y +z).($x^|$+y+$z^|$).($x^|$+$y^|$+z).($x^|$+$y^|$+$z^|$)

we know distributive form is

a+(b*c) =(a+b).(a+c)

F(x,y,z)=((x+y)+(z. $z^|$) ) .((x+$y^|$)+

(z. $z^|$)).(($x^|$+y)+(z. $z^|$)).

(($x^|$+$y^|$)+(z. $z^|$))

According zero property (x. $x^|$=0)

here z. $z^|$ becoming zero

= (x+y). (x+$y^|$). ($x^|$+y).($x^|$+$y^|$)

= (x+y. $y^|$). ($x^|$ + y. $y^|$)

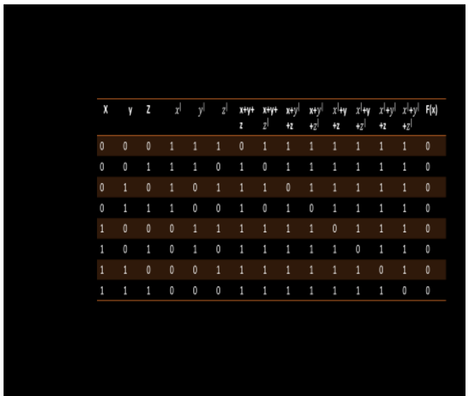
(zero property)

= x. $x^{|}$

= 0

So we prove ccnf is zero for given expression

TRUTH TABLE FOR CCNF:-



| X | y | Z | $x^{\|}$ | $y^{\|}$ | $z^{\|}$ | x+y+z | x+y+$z^{\|}$ | x+$y^{\|}$+z | x+$y^{\|}$+$z^{\|}$ | $x^{\|}$+y+z | $x^{\|}$+y+$z^{\|}$ | $x^{\|}$+$y^{\|}$+z | $x^{\|}$+$y^{\|}$+$z^{\|}$ | F(x) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |

## Conversion ccnf into cdnf:-

F(x,y,z)= (x+y+z).(x+y+$z^{|}$).(x+$y^{|}$+z).(x+$y^{|}$+ $z^{|}$).($x^{|}$+y+z)

.($x^{|}$+y+$z^{|}$).($x^{|}$+$y^{|}$+z).($x^{|}$+$y^{|}$+$z^{|}$)

F(X,Y,Z)= (x+y+z).(x+y+$z^{|}$).(x+$y^{|}$+z).(x+$y^{|}$+ $z^{|}$).

($x^{|}$+y+z).($x^{|}$+y+$z^{|}$).($x^{|}$+$y^{|}$+z).($x^{|}$+ $y^{|}$+$z^{|}$)

$F^{||}$(X,Y,Z)=

[(x+y+z).(x+y+$z^{|}$).(x+$y^{|}$+z).(x+$y^{|}$+ $z^{|}$).($x^{|}$+y+z).($x^{|}$+y+$z^{|}$).($x^{|}$+$y^{|}$+z).( $x^{|}$+$y^{|}$+$z^{|}$)]′

according to the property $a^{|}.b^{|}=a^{|}+b^{|}$

=(x+y+z)+(x+y+$z^{|}$)+(x+$y^{|}$+z)+

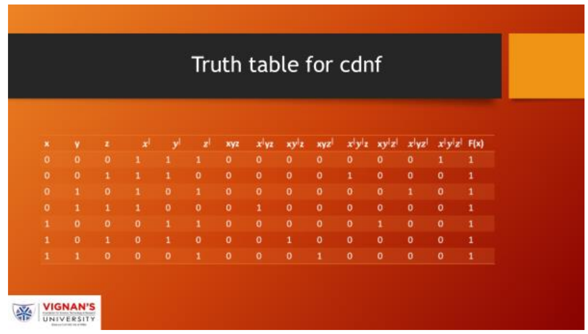
(x+$y^{|}$+$z^{|}$)+($x^{|}$+y+z)+($x^{|}$+y+$z^{|}$)+

($x^{|}$+$y^{|}$+z)+($x^{|}$+$y^{|}$+$z^{|}$)

Cdnf= (x+y+z)+(x+y+$z^{|}$)+(x+$y^{|}$+z)+(x+$y^{|}$ +$z^{|}$)+($x^{|}$+y+z)+($x^{|}$+y+$z^{|}$)+

($x^{|}$+$y^{|}$+z)+($x^{|}$+$y^{|}$+$z^{|}$)

=1




| x | y | z | $x^{\|}$ | $y^{\|}$ | $z^{\|}$ | xyz | $x^{\|}$yz | x$y^{\|}$z | xy$z^{\|}$ | $x^{\|}y^{\|}$z | x$y^{\|}z^{\|}$ | $x^{\|}$y$z^{\|}$ | $x^{\|}y^{\|}z^{\|}$ | F(x) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |

## CONCLUSION:-

We conclude that after brief study of Boolean algebra we are able to do convert ccnf to cdnf and we prove ccnf expression is zero and cdnf expression is one. And we construct truth table for both ccnf and cdnf after completion we understand ccnf and cdnf deeply. Now we are able to do ccnf and cdnf problems