AUTOMOBILE MOTIVE POWER CONVERTER AND INTERFACING WITH SMART GRID

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Signature: *Awais*

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Muhammad Awais: Automobile Motive Power Converter and Interfacing with Smart Grid

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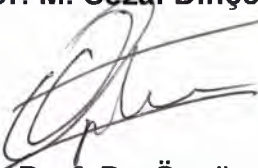
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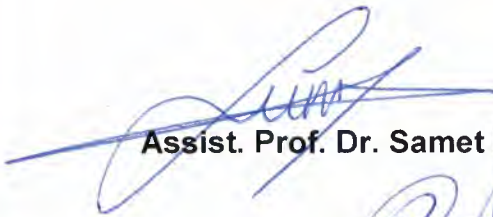|	
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ABSTRACT

Energy can neither be created nor destroyed, but can change form, we all know this law of conservation of energy. In our daily life we consume energy in one form to another. Different energy resources which have been used before e.g. fossil fuels caused pollution; Nuclear energy needs perfect handling to minimize its harmful effects. Now we are moving towards non polluted energy resources or renewable energy resources. It is an attempt to demonstrate how the K.E of vehicles on the road could be transformed to electrical and can be utilized at the neighborhood buildings or can be transferred to the nearest grid station.

Daily a lots of vehicles passes over the speed breaker that can be our power resources if we make a speed breaker to act as a power converter. The proposed system in this thesis takes input from the vehicles mechanical stress on the speed breaker can be converted to electrical energy in output. This technique uses a rack that moves vertically when an automobile passes across the speed breaker and it is linked to pinion that revolves when rack is pressed down with pressure by an automobile. This pinion is attached to a large sprocket, on a common shaft; the large sprocket is connected with a smaller sprocket by using a chain. There is another common shaft on which the small sprocket is attached with flywheels that enhances the rotations and gives input to large a gear, without any jerks, which is attached with a small gear identical in wind turbines to speed up the alternator to generate electricity.

If our proposed system works 12 hours daily then 24.7KW electricity can be generated that could be used for different purposes.

We used **MATLAB Simulink** for the simulation of the system to get results and used **3ds max** to show this phenomenon as real time animation.

This system can be used at parking plazas, at the entrance to shopping malls, filling stations and at toll tax center. The final results of the suggested system are quite sufficient compared with prior models. We can deploy an identical suggested system in parallel to increase the power rating.

Keywords: Renewable energy resources, Kinetic Energy, Electrical Energy, Automobiles, Rack and pinion, Gear, Alternator, Simulation, Animation

ÖZET

Her gün hız kesicilerin üzerinden geçen motorlu araçlar elektrik enerji üretiminde güç kaynağı olarak kullanılabilirler. Araçların hız kesiciler üzerine uyguladığı mekanik stres elektrik enerjisine dönüştürülebilir. Hız kesicilere bağlanan mekanik düzenek sayesinde elektrik üretimi yapılmaktadır. Bu tez bu şekilde elektrik üretimi yapan bir düzenek için **MATLAB Simulink** benzetim program ile yapılan bir modelleme sayesinde üretilen elektrik enerjisi ve sonuçları hakkındadır. Üretilen veriler hesaplanmış ve bu veriler kullanılarak şebeke bağlantılı veya şebekeden bağımsız çalışma irdelenerek sonuçlar verilmiştir. Sistemin kullanılabilecek muhtemel uygulama alanları öngörülerek sonuçlar literatürdekibenzer çalışmalar ile karşılaştırılmıştır.

Anahtar sözcükler: elektrik enerji, sonuçları hakkındadır, öngörülerek sonuçlar

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To my Parents and my Sisters, especially to my mother whose prayers made me able to do this work ......

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ABBREVIATIONS

AMPC	Automobile Motive Power Converter
DG	Distribution Generation
SB	Speed Breaker
SC	Short Circuit
DC	Direct Current
AC	Alternating Current
RPM	Revolution per Minute
SG	Smart Grid
VAR	Volt Ampere Reactive
KW	Kilo Watt
EP	Electrical Power
MP	Mechanical Power
K.E	Kinetic Energy

CHAPTER 1

INTRODUCTION

1.1 Overview

The basic and most cosmopolitan need of all works done by man is energy. In all types of work energy changes its form from one to another. Most common thinking about the word energy is what we getting inside our body as our diet or to machines and we therefore think about primitive energy sources, crude fuels and electricity.

In this chapter of thesis we are going to discuss the basic idea of the thesis. It includes some background related to it. The objectives to do this thesis and difficulties expected to do this are explained.

1.2 Background

Energy as electricity has become an important part of man's life. Electricity itself is one of the greatest inventions in the history of science. This has revolutionized the world and given inspiration to man to invent those things that seemed to be impossible a couple of centuries ago. The steady but increased usage of electric energy has brought major change to all kinds of industries. All our enormous and tiny equipments work with it. There is not even one thing in our daily life on which electricity has no impact. The clothes we wear are stitched with electrical machines. The books we read are printed with electrical machines. Our computers our mobiles our televisions everything runs on electricity. If we say that electricity has become a basic need of man's life we would not be wrong. This is truly called the era of electricity. It has completely changed our way of living and travelling as well such as electric trains and vehicles.

As we look around we will notice that our dependency on electricity is increasing day by day and our population is also increasing rapidly. Requirements of electrical energy are also increasing. This increment in need of electricity has a major effect on the economy of any country if it is totally dependent on producing electrical energy with conventional ways. Because in conventional ways we are using one source of energy i.e. oil to produce

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another source of energy i.e. electrical. In other words we are wasting one type of energy to get another. So this thing is forcing man to find other means to produce electricity in which our other energy reserves wouldn't be used and we can utilize that energy which we are wasting in our daily life without knowing. So we should think of the renewable energy sources in which there is no chance of using other energy reserves and which can minimize our cost of production of electricity.

In this era of information technology where the earth has become a global village the still dealing with three big issues, maintaining peace, poverty eradication, preservation of environment [1].

All routine energy sources will end one day. Now a day's most of countries are focusing on renewable energy resources as replacement, for power generation. As fuels are expensive in cost and as with increasing population and requirements of electricity it is no more affordable. It causes atmospheric pollution also. On the other hand nuclear reactors are not easy to control and could be dangerous as well. Thus renewable energy resources promise bright future. These are cheap in cost and non-polluted also.

In accordance to the renewable energy means, one should be more concerned pertaining to usage of natural resources. We should think about techniques to reutilize energy keeping this in mind that energy can't be created we have to change it into that form we need from that form we are wasting.

Many renewable resources can be found in our common life. The only thing we have to do some arrangements to convert these resources into required resources. By comparing conventional energy resources with renewable energy resources we will come to know that the later one is quite easy to control and cheap as well. Usually power is supplied to the users by the Grid stations but we can install our system near to the smart grid to decrease the cost or it can be transferred directly to users instead from Grid. It would be only possible if we can find an idea which can fulfill our needs in that particular domain either its domestic or commercial or industrial.

If we will have a quick look around us we will see that with the increase in population the road traffic has also increased enormously. A moving vehicle itself can be a big source of energy if we understand the value of that. Through the dissipation of heat energy and

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friction a huge amount of energy is lost at the speed breaker when a vehicle passes over that. If we design the speed breaker with few mechanical arrangements in such a way that it would work as power converter (from mechanical to electrical) then the electricity generation is guaranteed. It will convert vehicle motive power to electrical power for domestic use. It will definitely help in the economic growth of any country as we are not spending any money on any of raw material for electric generation. The use of energy is a symbolization of any emerging country.
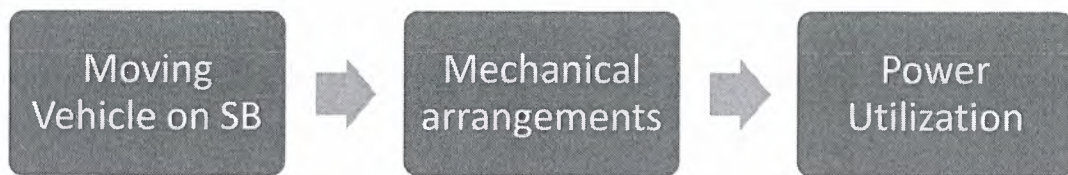
Figure 1.1 Simple block diagram of AMPC

An energy crisis in Pakistan is not new and it's not very rich economically also. Instead of going with old methods to produce electricity which are expensive as well we must go with these new technologies. By installing units of "speed breaker power converters" the shortage of electricity can be minimized with little expenditure.

1.3 Problem statement

Electricity is major need of routine life now. A technique is used to convert automobile's motive force exerted by its tires to electrical power with some mechanical arrangements in the speed breaker. We will use automobile motive power converter system for this purpose with good efficiency. And electrical power can be transferred to neighboring societies or to the smart grid.

1.3.1 Objectives

- The main purpose of this system is to get over the inadequacies of electricity of any country or to increase the growth of electricity.

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- To minimize the expenses that is used in production from conventional ways.
- System could be installed at suitable place near the place of requirement or to smart grid so the chances of line losses and theft will be less.

1.4 Research Contribution

In this thesis we tried to purify and improve the results comparatively to the previous researches by taking the practical values, like automobile's weight and wheel radius etc, to calculate our output. And we suggested using DC generator so that the generated output can be stored directly to batteries for further use. If the generated electricity is more than our need after charging the batteries then DC-AC converter system with Grid interfacing is also proposed in the thesis.

1.5 Difficulties

- Complicated mechanical arrangements of automobile motive power converter to make it more efficient and for regular generation of electricity.
- There is risk of Breakages if the vehicle heavier than system bearing limit passes over it.

1.6 Summary

This chapter was an introduction of this thesis. We discussed why we need this kind of energy resources with the increase in population. Our research contribution has been explained to improve this system and to get better results.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

Energy is essential aspect in all commercial and industrial advancement. Renewable energy implies the energy associated with recycling procedure and also from un-obtainable natural energy resources entirely above and over the actual traditions.

Electricity produced by different energy resources in the world is explained in this chapter. We will discuss the block diagram of our system step by step that we will perform in this thesis.

2.2 Background of Energy Converter System

Renewable vitality methods energy sources are generally restocked by Mother Nature i.e. Wind, Sun, Geo-thermal and Seawater. Different tools or machineries are used to convert these energies to required form of energy especially electrical.

Nowadays we mostly using petroleum and gas to run our cars, to warm our houses, to cook and even to generate electricity but these resources will end one day. Our requirements are increasing so we started using these resources rapidly. So despite these natural sources we should think about some non conventional sources.

Any country's energy needs can be estimated to grow 33% throughout the next 2 decades but our conventional resources are decreasing so renewable energy resources are capable to fulfill this space. Even if few countries have limitless oil reserves according to their needs but renewable energy resources are much healthier for environment whereas the other hot fuels causes' green house effect and causing the earth temperature go high.

On the other hand these renewable resources can't fully meet our requirements. Dependency on these resources should be partially. For example solar energy will be definitely decreased on grey days or peaceful weather will never be helpful to run wind turbines. Even we use these systems as supplementary it will be quite helpful and cheap as oil prices going very high. [1]

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The production and usage of renewable energies has grown rapidly in modern days. Before going through the whole procedure of electricity generation we see the customer's requirement and finances also. Electricity production from renewable is low priced and atmospheric friendly. The generation of electricity from road traffic also doesn't harm the environment. However the system must be efficient to satisfy the requirements of user and if there is any extra energy it would be transferred to SG. A whole AMPC consists.

- Substantial fulfillment regarding consumer capacity.
- Establishing an efficiently immaculate engendering area
- Efficient coordinating layout involving mental ability ever-changing via neighborhood classic energy location to be able to SG

Despite the fact AMPC has many benefits but as well as some problems or difficulties also which are;

- Mechanical arrangements
- Consumer prerequisites managing and connecting to SG
- Electric apparatuses

Mechanical parts need proper arrangements to make the system more efficient and to avoid the breakages. These parts can be expensive and can increase the budget. Alternator plays key role in this AMPC system which is part of electric work. The input from mechanical system drives the alternator to produce electrical energy. And managing the produced power will be supplied directly to user if it's near about the AMPC or to preserve on battery banks or to SG.

Energy source or fuel	Approximate percentage of total electric generation	Steam cycle 85 per cent	Hydro-electric 13 per cent	Combined steam- and gas-turbine cycle 1 percent	Combustion turbines 1 percent	Internal combustion engine (diesel) 1 percent	Photo-voltaic	Wind turbine	Fuel cell	Magneto-hydrodynamic	Thermo-electric	Thermo-ionic	Open-steam or closed-ammonia cycle
Coal	44	X							X	X	X	X	
Oil	16	X		X	X	X			X	X	X	X	
Natural gas	14	X		X	X				X	X	X	X	
Elevated water supply	13		X										
Nuclear fission (uranium or thorium)	13	X											
Geothermal	0.15	X											
Refuse-derived fuels		X											
Shale oil		X		X	X				X	X	X	X	
Tar sands		X		X	X	X			X	X	X	X	
Coal-derived liquids and gases		X		X	X	X			X	X	X	X	
Wood		X											
Vegetation (biomass)		X											
Hydrogen		X				X			X	X	X	X	
Solar		X					X						
Wind								X					
Tides			X										
Waves			X										
Ocean thermal gradients													X
Nuclear fusion		X											

Figure 2.1 Different types of electricity generation systems [2]

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Energy Source (fuel) and generation-system type	Fuel cost	System efficiency	Capital cost $/kW	System operation and maintenance (excluding fuel) costs, $/MWh	Largest available unit ratings	System reliability and availability	System complexity	Fuel availability	Cooling water requirements	Major environmental impacts
Coal-fired steam cycle	Intermediate	High	Very high	Low to medium	Large	High	Very high	Best	Large	Particulars, SO_x and oxides of nitrogen (NO_x) in stack gases; disposal of scrubber sludge and ashes
Oil-fired steam cycle	Highest	High	High	Lowest	Large	Very high	High	Fair	Large	SO_2 and NO_x in stack gases; disposal of scrubber sludge
Natural-gas-fired steam cycle	High	High	High	Lowest	Large	Very high	High	Fair	Large	NO_x in stack gases
Nuclear	Low	Intermediate	Highest	Medium	Largest	High	Highest	Good	Largest	Safety; radioactive waste disposal
Oil-fired combustion engine	Highest	Low	Lowest	Highest	Smallest	Lowest	Moderate	Fair	Smallest	SO_2 and NO_x in stack gases
Natural-gas-fired combustion turbine	High	Low	Lowest	Highest	Smallest	Lowest	Moderate	Fair	Smallest	NO_x in stack gases
Oil-fired combined cycle	Highest	Very high	Intermediate	Medium	Intermediate	Medium	Moderate	Fair	Moderate	SO_2 and NO_x in stack gases
Natural-gas-fired combined cycle	High	Very high	Intermediate	Medium	Intermediate	Medium	Moderate	Fair	Moderate	NO_x in stack gases
Hydroelectric	Lowest	Highest	Intermediate to highest	Low	Large	Highest if water is available	Lowest	Limited by area	Small	Generally requires construction of a dam
Geothermal steam	Low	Lowest	Intermediate	Medium	Intermediate	High	Low	Extremely limited by area	Low	H_2S emissions from system

Figure 2.2 Comparison of different electricity generation systems [2]

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2.3 Classification of AMPC Problem

Issues related to AMPC can be divided into two parts first is related to arrangements and controlling and second is transmission of electricity and supervision.

2.3.1 Subterranean Power House concern

Subterranean power house is an underground room beneath Speed breaker and the road traffic passes over it. This power house comprises all mechanical arrangements and alternator which can be DC (for use of battery banks) or AC (for direct supply to end user), depends on our requirement. It takes moderate development nonetheless SB essentially condensed with fiber and it has ability to allow the rack to move up and down according to the task.

2.3.2 AMPC

Here all the working of AMPC system is explained with rack and pinion collaboration. Rack is connected to speed breaker and it moves up and down when the task is performed. The pinion is attached to the sprocket according to our arrangement on a shaft. This sprocket technique comprises two sprockets i.e. big and small. Big sprocket is connected to small sprocket with the help of chain. This chain transforms power from big sprocket to small one. By doing this we get more speed at small sprocket comparatively to large sprocket. And after that a pair of gear box is attached with small sprocket [3].

The gear wheel with even bigger rating is attached with the small sprocket axis. Thence the celerity by the smaller sprocket is acknowledged on the gear wheel of bigger rating. In the gear box also the substantial sizing wheel is joined to smaller controls. The rotations generated in the result are the multiple of intensity. This fastness will be fair enough to rotate the alternator. The rotor coil which reductions your magnetic flux around inside it in a stationary magnet stator coil. This produced electromotive force (emf) is transferred to inverter if the alternator is AC to store on the batteries so it can be used for lightening at night time or for any other purpose.

With the increase in population road traffic or number of vehicles also increased on roads. To control the speed of vehicles in busiest areas SB are built to cut down the vehicle's

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speed. When a vehicles passes over the SB it pushes the rack down it rotates the pinion and pinion rotates the big sprocket and then after big sprocket rotates the small sprocket with the help of chain. That helps to move the flywheel which uniformly moves the two gears in gear box and avoid the jerks. These gears rotate the alternator which converts mechanical energy to electrical [4].
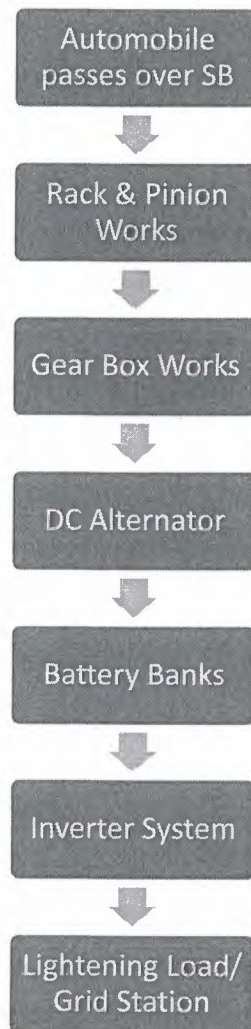
```
┌─────────────────────┐
│    Automobile       │
│   passes over SB    │
└─────────────────────┘
          ↓
┌─────────────────────┐
│   Rack & Pinion     │
│      Works          │
└─────────────────────┘
          ↓
┌─────────────────────┐
│   Gear Box Works    │
└─────────────────────┘
          ↓
┌─────────────────────┐
│    DC Alternator    │
└─────────────────────┘
          ↓
┌─────────────────────┐
│    Battery Banks    │
└─────────────────────┘
          ↓
┌─────────────────────┐
│   Inverter System   │
└─────────────────────┘
          ↓
┌─────────────────────┐
│  Lightening Load/   │
│    Grid Station     │
└─────────────────────┘
```

Figure 2.3 AMPC complete block diagram

If we compare number of vehicles in our city with number of vehicles 10 years before we can observe that the number has increased swiftly. The core thought of doing this research work is to utilize some of energy by vehicles exerted on the road through AMPC to electrical energy that can be very helpful to fulfill the electricity deficiency. It seemed to be unusual to generate voltage by moving vehicle on speed breaker but by the changing of time means of getting energy are also changed. This simply works on the basic ENERGY CONSERVATION LAW. In this the vehicle stress is used as mechanical energy input to the system which gives us electric energy as output.

2.4 Alternator selection

Alternator is a device that takes M.E as input and gives us E.E as output. The rotating coils of wire and magnetic flux are used to alter rotary motion to pulsating DC according to the faraday's electromagnetic induction law. A dynamo comprises a stator that is immobile part and supplies permanent magnetic field, and armature that consist of rotary winding it rotates inside of field [5].

Permanent DC generator is used in this thesis. The rating of DC generator is 12V. 12 volt batteries are used to store this voltage. An inverter is connected with this battery bank to convert DC to AC. It converts 12V DC to 220V AC for domestic use. To increase the power rating we can increase number of batteries and inverter circuits. The all arrangement is subterranean apart from SB [6].

2.5 Optimization of AMPC Problems

In this thesis MATLAB SIMULINK model of Automobile Motive power Converter is developed with an improved scheme. Formerly mechanism was used for this process which works as generator before 10 years. Later on roller mechanism is replaced by crank shaft technique. But the last and most modern technique which is used for this process is Rack-pinion mechanism. This is connected with spur gear for electricity generation process. The M.E of vehicle is converted to Electrical with almost 50% efficiency.

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When we estimate the output by this mechanism the Geometry information is derivative in sorting a theoretical framework. Subsequent now very well-described generalization that might be utilized to indicate concept highly relevant to geometry:

- Vehicle speed is very important in this process because the relationship is inversely proportional between vehicle speed and produced voltage. System gives high efficiency when the speed is around 10 km/h.

- Another important part of the system which plays significant role is Flywheel. It avoids breakages and avoids abrupt jerks. It persists the generation without any cut off and maintains the machine stability with its inertia.

  Gear of alternator must be smaller

In this mechanism the Car alternator can be used because of its additional advantages than other conceivers in these circumstances under these mechanical arrangements on road. For small scale generation this alternator can be very useful. It can be utilized for generation around 70 watts to 5 KW. It has ability to operate at 200 rpm to 8000 rpm. We will use an AVR in our system also which will safe guarding frequent voltage process and power factor. Load can be directly connected to the alternator's output or through batteries. If the supply is more than our need it will be transmitted to Grid station [5].

2.6 Comparison of different AMPC schemes

It is comparison between different AMPC systems. Few named as 'SB power generation' or Power generation by road traffic etc. This work is done in MATLAB SIMULINK with 3d max real time simulation. The proposed design generates 24.7KW power in a day.

Table 2.1 Comparative Table

Author's Name	Title of topic	Output in kwh/day
Aswathaman.V Priyadharshini.M	Every SB is now source of energy	5.866
Mohsin patodezfoli. Abbas Rezaev. Zahra Baniasad. Horieh Rezeav	A novel speed breaker for electrical energy generation suitable for elimination of remote parts of power systems where is near to roads	16
Noor Fatima, Jivaul Mustafa	Production of electricity by the method of road power generation	7.06
K.Ravivarma. B.Divva. C.P.Prajith. A.Sivamurugan. K.Vengatesan	Power Generation Using Hydraulic Mechanism at Speed bumper	4.5
Ashok Kumar Sharma , OmkarTrivedi . UmeshAmberiya . Vikas Sharma	Development of speed breaker device for generation of compressed air on highways in remote areas	N/A
Alok Kumar Singh , Deepak Singh , Madhawendra Kumar , Vijay Pandit . Prof. Surendra Agrawal	Generation of Electricity through Speed Breaker Mechanism	N/A
AmanpreetKaur, Shivansh Kumar Singh , Rajneesh , Parwez . Shashank	Power Generation Using Speed Breaker with Auto Street Light	N/A
Mohammad Uzzal HossainJoardder. Md. MamunKabir. RanjovBarua. Md. EmdadulHoque	Production of Power From Speed Breaker	N/A
Rajat Gupta, Suvash Sharma, SaurabhGavkawad	A Revolutionary Technique of Power Generation Through Speed Breaker Power Generators	N/A
Srivastava .Ankitasatha	Produce Electricity by the use of Speed Breaker	N/A
Ankita. Meenu Bala	Power Generation from Speed Breaker	N/A
Md.SaifulIslam.Syed Khalid Rahman.Jakeva sultana Jyoti	Generation of Electricity Using Road Transport Pressure	N/A

2.7 Summary

All steps that we have to do in this thesis through block diagram. DC alternator has been suggested. Because of this we will not have to convert generated power to store on batteries. And comparative table shows the output results of other studies.

CHAPTER 3

DIFFERENT DESIGNS FOR ENERGY CONVERTER

3.1 Overview

Converters are widely-used for a long time. Here in this thesis, the converter which is used converts mechanical energy to electrical. Different types of old techniques have been discussed in this thesis that is being used to utilize motive power of vehicles.

3.2 Introduction

An effort has been done in this thesis to show how energy can be reused exerted by the vehicle on road while crossing Speed breaker. Every single time when a vehicle passes on the SB, a good amount of energy is wasted by heat and friction. An endeavor is elaborated to utilize this energy by doing some mechanical arrangements under the speed breaker.

3.3 Old Techniques

There are four different techniques used to generate the electricity by speed breaker. Those are following

- Roller mechanism
- Crank-Shaft method
- Spring coil method

Here all these techniques are explained briefly.

3.3.1   Roller Mechanism

In this technique the speed breaker acts as a roller to rotate the alternator by using belt and pulley. This method was the first attempt to generate electricity by speed breakers. Though, the system was not very efficient but it opened the paths of research in this field [7].

3.3.2 Design

1-SPEED BREAKER
2-GENERATOR
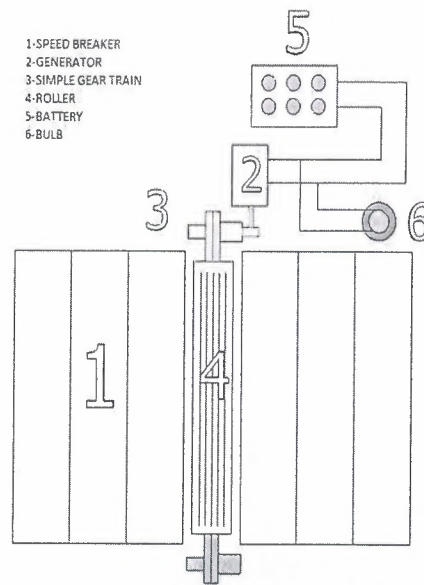3-SIMPLE GEAR TRAIN
4-ROLLER
5-BATTERY
6-BULB

Figure 3.1 Roller mechanism [7]

In this method a roller is fixed in the SB. It makes speed breaker to behave like a roller. When a car passes across the SB it rotates the alternator, which is attached to it. This phenomena uses DC alternator and the generated voltages are stored in the battery.

3.3.3 Drawbacks

- Very Low efficient
- Difficult maintenance
- No safety measures to avoid jerks and breakages
- Might cause accidents for Bicycle or Motor Bike crossing SB at slow speed right after a car passed across SB on high speed. Because after the car has passed the roller would be revolving at comparatively high speed than the bicycle due to inertia.

3.4 Crank-Shaft Method

This mechanism is also not one of the best one but it is comparatively improved to previous one. In this method a crank-shaft is fixed as mechanical arrangements in SB to rotate the alternator.

3.4.1 Design

The working principle of the crank-shaft is to convert straight movement to the rotary movement or from rotary movement to straight. Pistons of all vehicles are example of this phenomenon as those moves up-down but in the result the wheels of the car rotate [8].
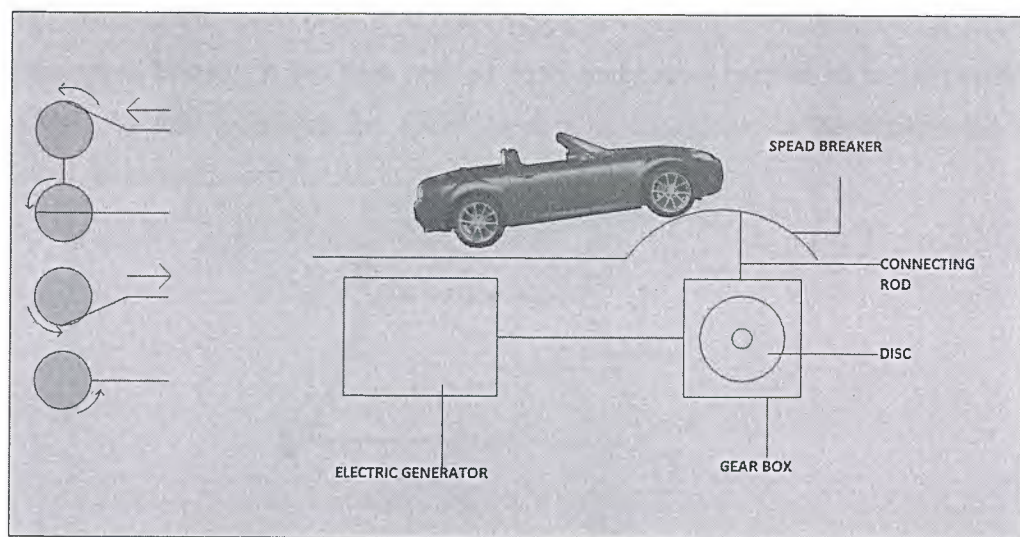
Figure 3.2 Crank-Shaft mechanism [10]

3.4.2 Drawbacks

- Crank shafts are needed to be fitted with bearing which leads to balancing problem and can cause mechanical oscillations that can damage bearings
- Variable load (quite often in the case of different vehicles) can cause also balancing issue because the bearings are of sliding type
- Not very efficient

3.5 Spring Coil Method

Its working principle is to convert mechanical energy to electric energy. According to Michael Faraday "EMF induced around a closed path is proportional to the rate of change of magnetic flux through any surface bounded by path" By this we can think that electric current will be produced in a close loop if the magnetic flux varies in that area if we are using magnet plates on side. It's not very common method the other method which we use in this technique is following.

3.5.1   Dimensions and Design of Speed Breaker

In this mechanism the speed breaker is constructed in vibrating form. When a car passes across the speed breaker, it has been pressed down and comes back to its initial position soon after.   In this technique the speed breaker is considered to be constructed in trapezoidal shape and material used in its making is steel.
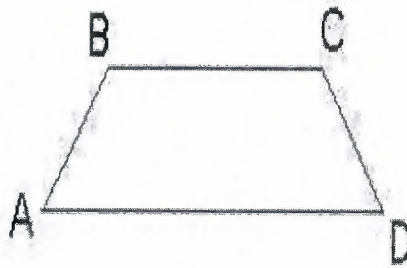
Figure 3.3 SB design [9]

Here the vehicle will be coming from 'A' side the load starts working on AB side. It will press the speed Breaker down. It will be at its maximum position between B-C and minimum between C-D. The dimensions of SB should be

$Width = .4m$

$Length = 4m$

$Height = .2m$

While constructing the base coating of the trench is made by .5m thick wood or with cement for the cushion effect. The actual length of spring is .3m before load. And the deviation can be calculated by

$$\delta = 64w * n * N * \frac{R^3}{Gd^4} \tag{1}$$

Where 'w' is load, 'δ' is deviation in spring, 'n' is No. of spring's turns, 'N' is number of springs, 'R' is coil's mean diameter, 'G' is modulus of rigidity and 'd' is wire's diameter.

When vehicle passes across the speed breaker at its maximum load position, the pressurized air volume can be found by

$$Vol.\,of\,pressurized\,air = Vol.\,of\,air\,at\,baseborn - Vol.\,of\,spring \tag{2}$$
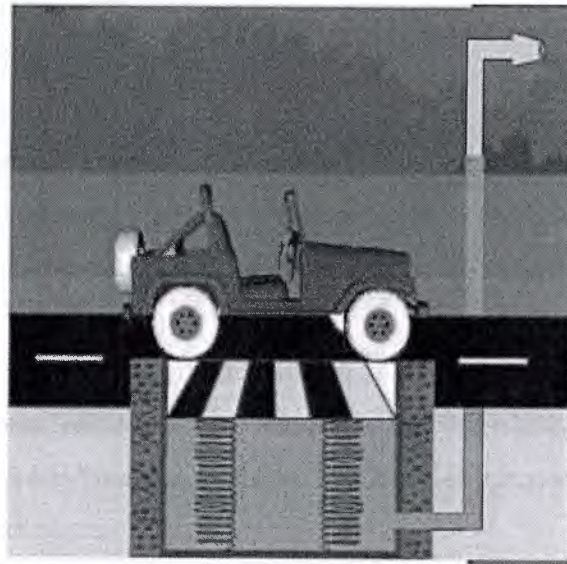
Figure 3.4 Springs in compacted form [9]

In the figure we can see the whole bottom unit and pressure nozzle. So at the time of vehicle passing the pressure increases in the unit when it crosses the predefined limit it opens the valve and forwards it to nozzle. Intake side of nozzle must be bigger than release side which converts the pressure energy to kinetic energy. When this high velocity condensed air strikes the impeller of wind generator or alternator the electricity is produced [9].

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3.5.2 Disadvantage

- comparatively expensive
- Slow in production
- More area needed

3.6 Rack-Pinion

In this thesis we are working on this mechanism. This mechanism is comparatively new among all and more efficient. The main advantages of this technique is

- Low budget
- Covers less area
- Could be up to 95% efficient
- No obstruction to traffic

About the disadvantage in this method is Equipment might get corroded in more rainy areas or it might not give good efficiency on low weight vehicles or motor bikes. We will discuss about its design in detail in next chapter [9].

3.7 Summary

Roller mechanism, crank shaft method and spring coil mechanism were the old techniques that were used. These old techniques were not very efficient. The newer method to perform this task is Rack-Pinion mechanism. It is more efficient and reliable. Our thesis is also based on this technique.

CHAPTER 4
DESIGN AND DIMENSIONS FOR AMPC

4.1 Overview

Different types of speed breaker design have been discussed here. Rack and pinion calculation and gear's output has been calculated according to our requirements. Basic design of DC generator has been discussed in this chapter of thesis. To make this work practically implemented, all real life values like vehicle's weight, its wheel radius and standard speed breaker dimension has been taken. This chapter includes the brief introduction of smart grid also.

4.2 Speed Breaker Design

Speed breakers are designed to cut down the vehicles speed around 10 km/h. Three standard speed breakers of ISO-9002 standard are shown below:

- RK-10
- RK-18
- RK-36

4.2.1 RK-10

- Each section weighs about 14lbs and dimensions are 10" W x 24 L x 2-1/8" H
- Each section comprises reflective 'X' carved-in marking in yellow color at center

RK-10 X 6

10"

24"

24"

24"

2-1/8""
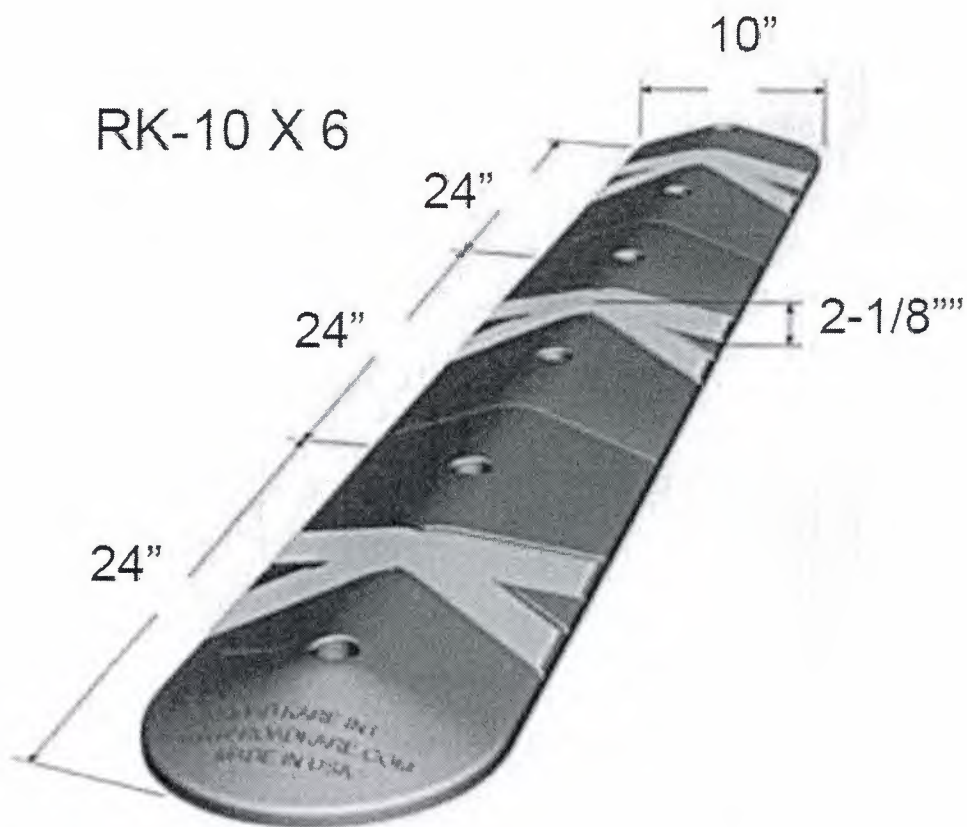
Figure 4.1 RK-10X6 SB [11]

4.2.2 RK-18

- Each section weighs about 27lbs and dimensions are 18" W x 24 L x 2-1/4" H
- Two 8'' yellow reflective stripes are carved-in marking in center of each section

RK-18 X 8

18"

24"

24"

2-1/4"

24"

24"

24"
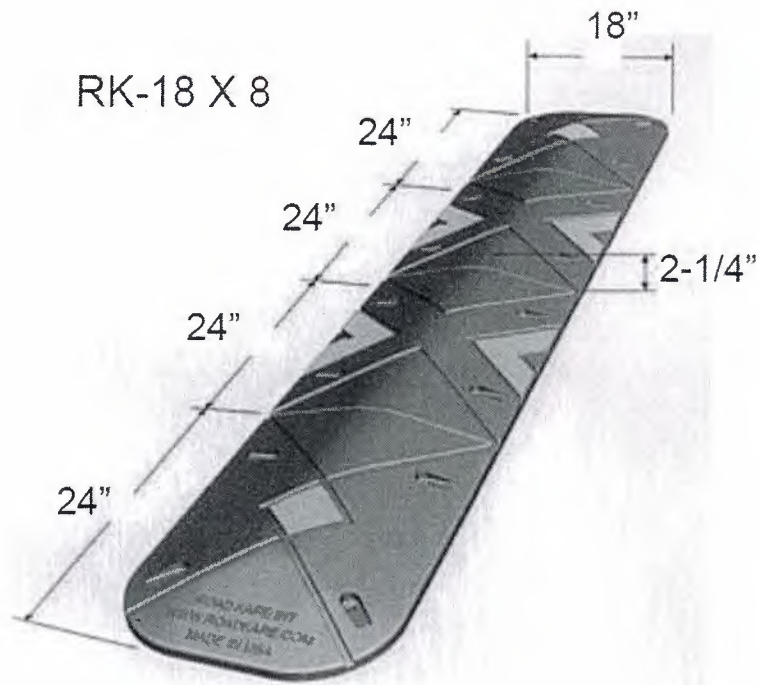
Figure 4.2 RK-18X8 SB [11]

4.2.3 RK-36

- Each section weighs about 53lbs and dimensions are 36" W x 24 L x 2-1/2" H
- Two 8'' yellow reflective stripes are carved-in marking in center of each section
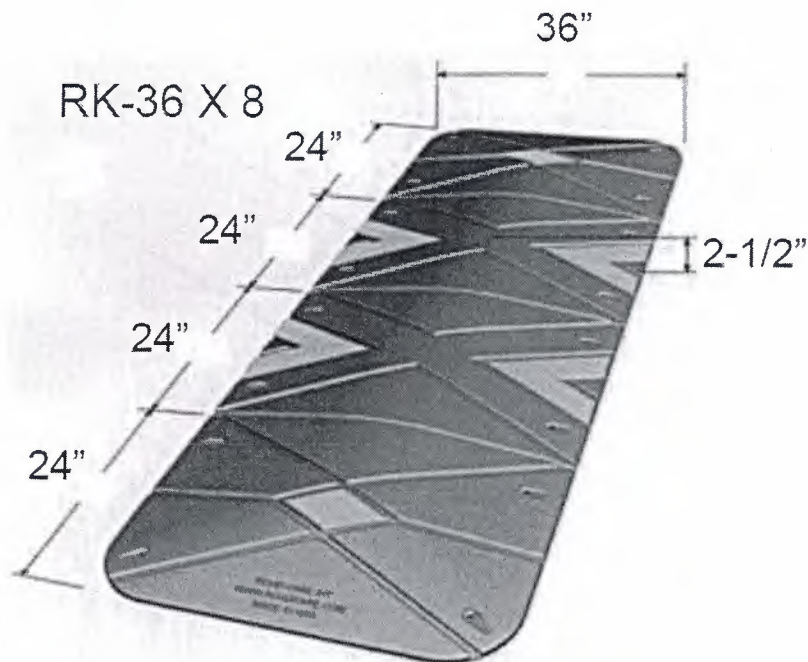
Figure 4.3 RK-36X8 SB [11]

4.3 Material and life time

These speed breakers are made by 100% recycled black colored rubber containing polyurethane binder. There is no rubber dust and granules in fiber form rubber. It is easily adjustable to pavement without any variance. Life time of these speed breakers are two years.

RK-10 is more suitable for our thesis to reduce the speed of vehicle around 10 km/h that is more efficient [11].

4.4 Rack-Pinion Design

Rack and pinion plays important role in our thesis. The rack is attached with speed breaker to change translational motion to rotary motion with the help of pinion. This pinion is attached with the gear to run the alternator. There can be 8-10% losses due to friction.
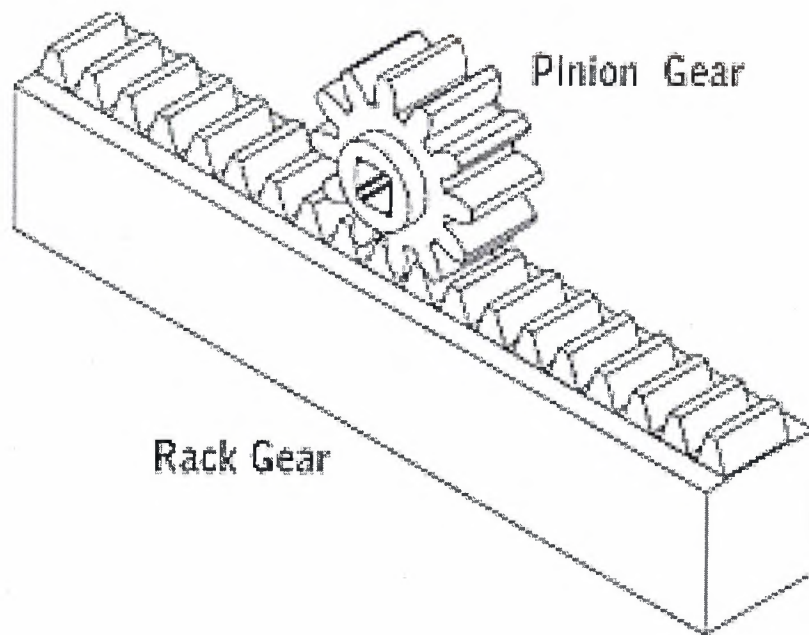
Figure 4.4 Rack and pinion [12]

4.4.1 General Rack Calculations

Pitch circle Dia. = D =60mm

No. of teeth = T =20

Module (m) =D/T =60/20=3

Circle radius (r) = D/m =60/3= 20mm

Module =Addendum (a) =3mm

Radius of addendum circle $(r.a)$ = $r + a$= 20+3=23   (3)

Pinion angle =20°

Rack's length min = $(r.a)(2\pi)$ = 144.45mm   (4)

4.4.2 General Pinion calculation

Outer Dia. =60mm

No. of teeth = 20

Module =D/T = 60/20=3

Diameter of pitch circle (D) = $60/(1 + 2/N)$ = 52   (5)

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Diametral Pitch (p) = 20/60= .34mm

Addendum (a) =1/ (.34) =2.94mm

Dedundum (d) = 1.5708/ (.34) =4.6mm

4.4.3 Rack-Pinion Selection

Generally Toyota and Chevrolet cars weigh around 1400 kg. While passing on speed breaker each axle exerts force with 350 kg approximately. Here we assume a mass of 750 kg to be moved on SB that is little bit more than mass of two axles. Suppose vehicle takes 2 seconds to move on SB with speed of 10km/h.

m=750kg

v=10km/h=2.77m/s

t=2s

g=9.81m/s^2

Friction coefficient (μ) =0.1

Lifetime factor (f_n) = 1.25

Load factor (K_a) =1.5

Safety coefficient (S_B) = 1.2

Linear load factor (L_{KHB}) =1.5

$a = v/t$=1.39 m/s^2

$$F_u = \frac{(m.g.u)+(m.a)}{1000} = 1.77kN* \tag{6}$$

"For this feed force we assume inductive hardened rack C45, module 3, case hardened pinion 16MnCr5 with 20 teeth having this bearing force F_{utab} = 11,5 kN"

Calculating permissible feed force

$Fu_{rack}/per = Fu/ SB .Ka.fn. L_{KHB} = 3.375kN$

(7)

$Fu_{rack}/per > Fu$ Condition is fulfilled to select this rack and pinion from the ATLANTA catalogue we can select the Rack (27 30 101) and Pinion (24 35 220) [13] [14].

4.5 Gears

A rotating device with cut teeth that are interlocked with another toothed component to transfer torque is known as cog wheel or gear.

4.5.1 Simple Gear

As we know a gear is a rotating machine edges like teeth. It is assumed to be a simple machine which gives us mechanical benefit when couples of gears are working in conjunction and this phenomenon is called transmission. These simple geared machines can be used to vary torque, speed or direction of a source. And when a gear is interlocked with non-rotating but toothed part, known as rack it gives us translational output instead of rotational.

When 2 gears are interlocked, the mechanical benefit which we get as result is of the relationship between ratios of their teeth.
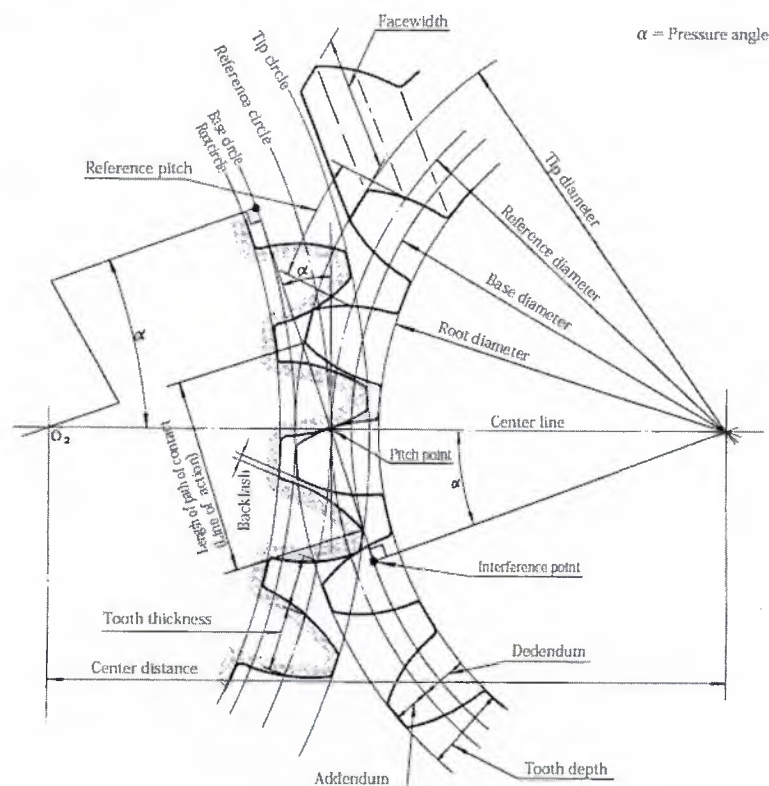
Figure 4.5 Specification of gear [15]

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4.6 Sprockets and Chains

If we simply see the bicycle we will notice that it is driven by bigger driver sprocket which gets input force because it follows very simple ratio rule that is

No. of teeth on bigger sprocket/ No. of teeth on smaller = 60/20=3   (values assumed)
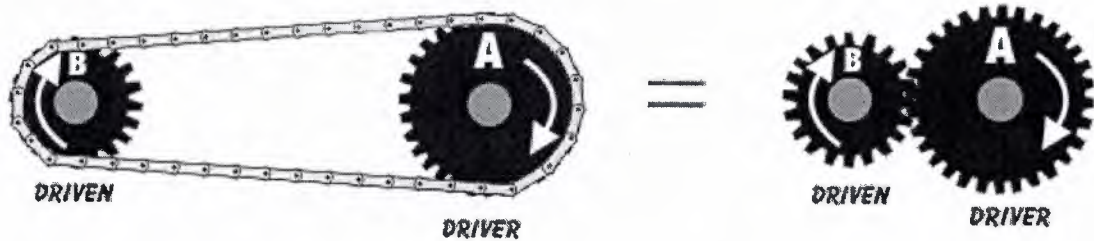
Figure 4.6 Sprockets and chain [16]

The ratio tells that if bigger sprocket moves once the smaller will move 3 times.

4.7 Spur Gear

This is most common and simple type of gears. These gears are parallel to shaft and having straight teeth. It transfers motion and power between two shafts which are parallel to each other. Few characteristics of spur gear are

- Easy manufacturing
- No axle force
- Comparatively much easier to develop top quality gears
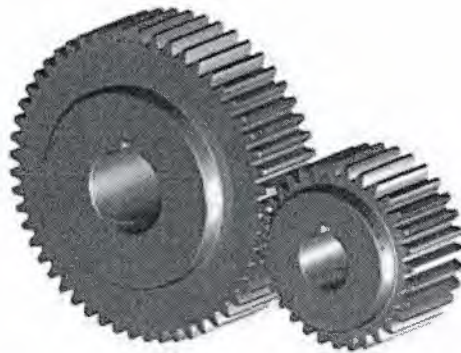
Figure 4.7 Spur gear [17]

4.7.1 SPUR Gear Dimensions

No. of teeth =20

Outer Dia.=55mm

Pitch Dia.=50mm

Pitch =.4mm

Pressure angle=14.5°

Whole Depth=5.3

Root Dia.=44.2mm

Addendum=2.5mm

Dedendum=2.89mm

Clearance=.39mm

Circular Tooth Thickness=3.9mm

Circular Pitch=7.85mm

Chordal Addendum=2.57mm

Chordal Tooth Thickness=3.92mm

Base Circle Dia.=48mm

If we have following input conditions

Load type=medium shock

Duration=10 hour daily

Gear type=spur

Pitch =.4

Pressure angle=14.5°

No. of teeth=20

Face width=25.4mm

RPM=80

Material = 4140 PRE-HT

Safe stress =44000

The output velocity will be. 1048FPM=2034RPM

For this RPM we can use many car alternators like 3YM30.
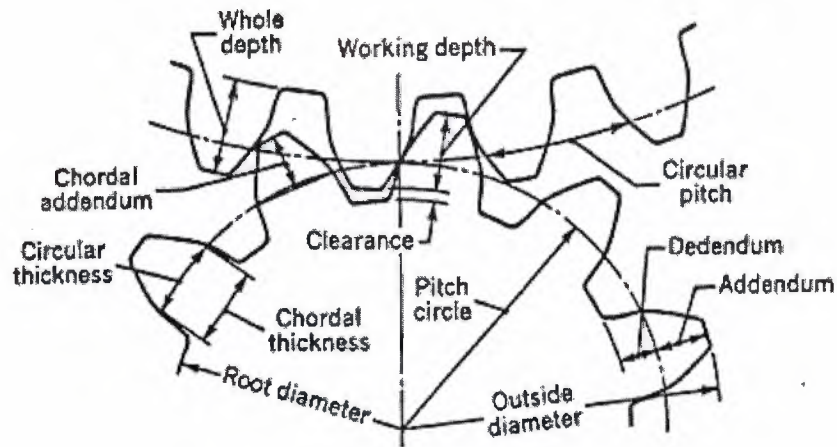
Figure 4.8 Spur gear structure [18]

4.8 Shaft Dimensions calculation

A solid circular shaft shear stress can be calculated with the following formula

$\tau = T.r/J$

Whereas

τ=shear stress

r= radius of shaft

J=moment of inertia

T= twisting moment or transferred torque

Moment of inertia can be calculated by

$$J = \pi r4/2 = \pi (D/2)4/2 = \pi D4/32 \tag{8}$$

If D is 250 mm J=3.8 x 10^{-4} mm^4

$$T = r.F.g = .125x490.5x9.81 = 601.4 Nmm \tag{9}$$

Because force is acting downward so we will include factor 'g' also and F we assumed minimum force exerted by bicycle weighs 50 kg.

τ= 2 N/mm^2[19].

4.9 Alternator

An electric generator which alters mechanical energy into electrical energy with stationary armature and rotating field is known as alternator.

4.9.1 Mechanical and Electrical Comparison

A useful comparison of Mechanical and Electrical is shown in the following figure. There is a fascinating comparison that can be beneficial for both electrical and mechanical to learn the physical procedure of both types of energy.
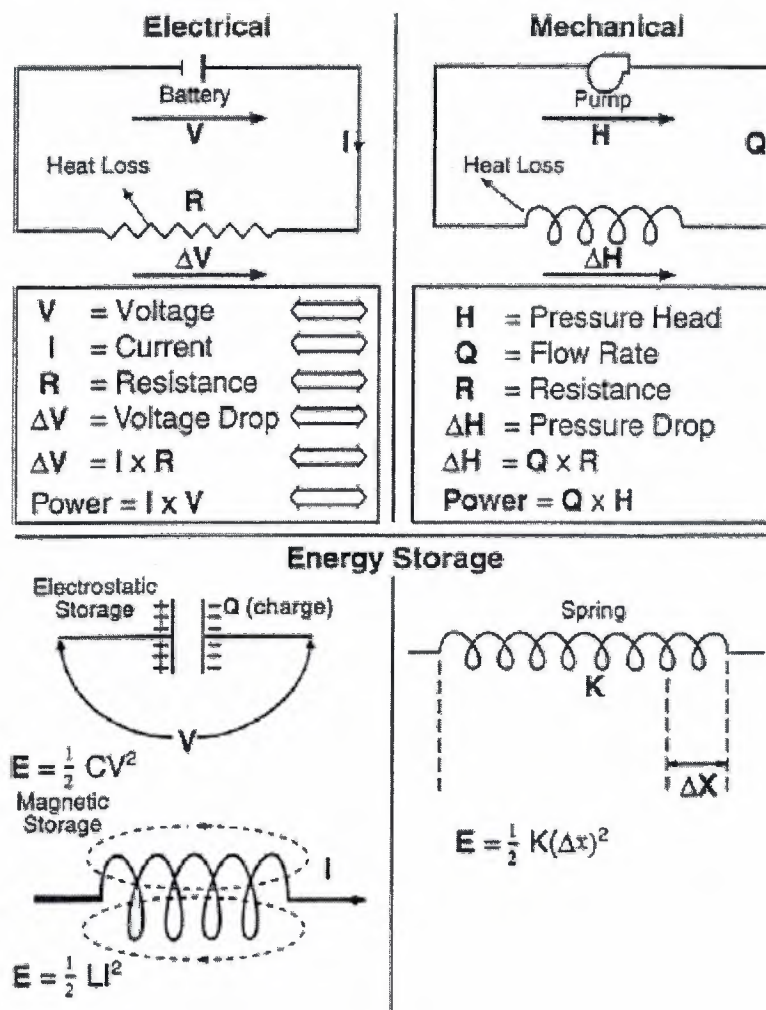
Figure 4.9 Mechanical-Electrical comparison [20]

DC can be assumed as a form of AC with zero frequency. Hertz is the international unit of frequency that counts cycles per second in other words it counts how many times voltage or current alters its polarity. A rotating vector used in calculation of electrical problems is called phasor it makes the calculations simple. There are few parameters of electrical circuit i.e.

The active power

$$P = E \ x \ I \ x \cos \varphi \ (units \ are \ watt) \tag{10}$$

The apparent power

$$S = E \ x \ I \ (units \ are \ Volt - Ampere \ or \ VI) \tag{11}$$

The reactive power

$$Q = E \ x \ I \ x \sin \varphi \ (units \ are \ Volt - Ampere - Reactive \ or \ VAR) \ [20]. \tag{12}$$

4.9.2   DC Generator operating principle

Mechanical energy can be converted to electrical with the help of generator. When a conductor moves within magnetic field in such a way that it cuts lines of magnetic flux an e.m.f is induced and according to Faraday this e.m.f causes the flow of current if the circuit is closed.

"The induced e.m.f magnitude is equal to the rate of change in the lines of magnetic flux." is the Faraday's second law. And about the induced current Lenz says that "In a conductor, the induced current is in such a direction as to oppose the change in the magnetic flux. The direction of movement of conductor, direction of induced e.m.f and direction of flux can be found by Fleming's right hand rule.
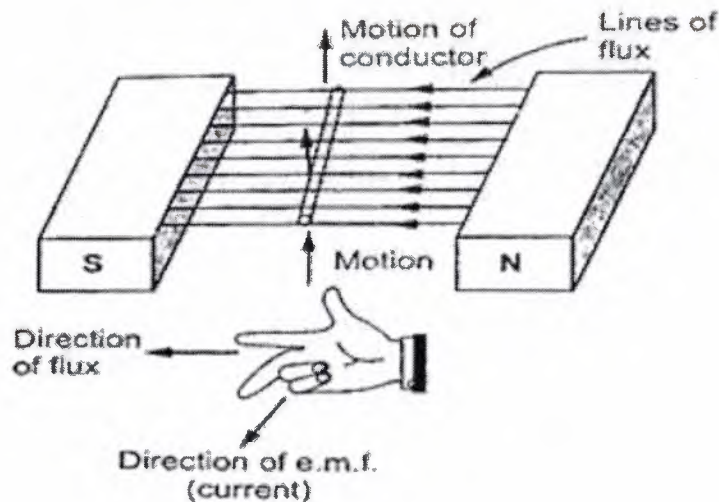
Figure 4.10 Fleming's right hand rule [21]

Few basic things, needed for the induction of e.m.f are

- Consistent magnetic field (can be electro magnet or permanent magnet)
- Conducting coil (aluminum or copper)
- Movement (can be done by turbine or prime mover)

A basic generator comprises an armature, brushes, slip rings, magnetic field and resistive load. Armature consists of conductive wires that rotate in the magnetic field and causes the induction of e.m.f. When conductor moves in the magnetic field e.m.f is induced in that. Slip rings are connected to armature and rotate when armature rotates. Carbon brushes are attached to the slip rings to carry out current to the resistive load. From the figure below we can find the path of the current in both half cycles [21].
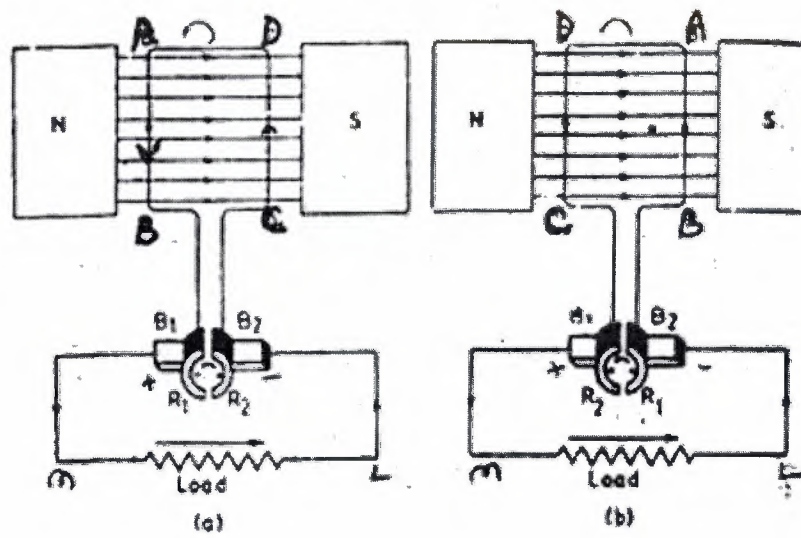
Figure 4.11 Current path [21]

(0°-180°) current path is $DABB_1R_1MLR_2B_2C$

(180°-360°) current path is $ADCB_1R_2MLR_1B_2B$

4.9.3 Constructional Details

A DC generator consist of these parts shown in the figure with their names
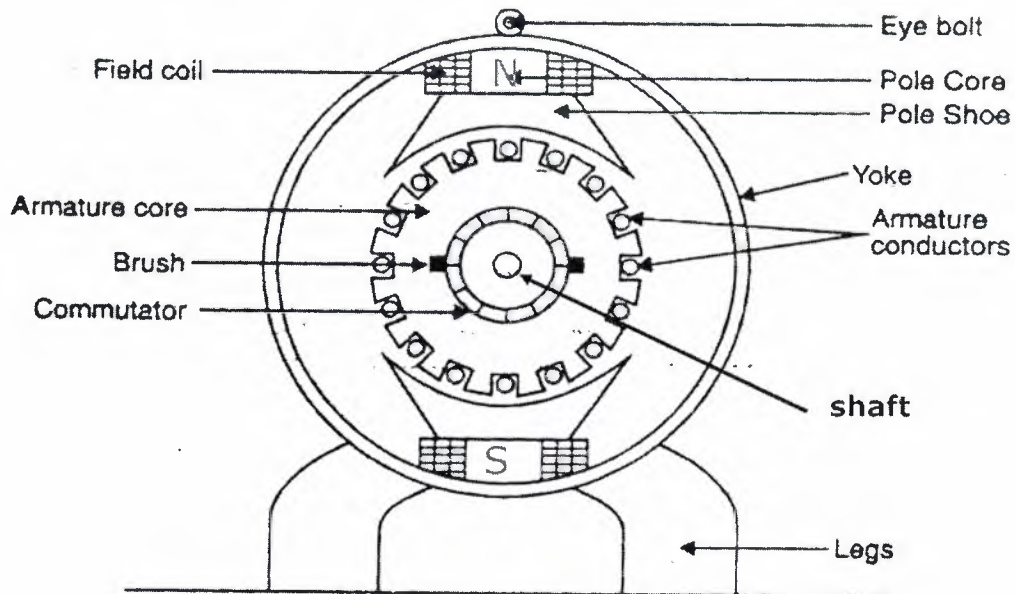
Figure 4.12 Constructional diagram of generator [21]

4.9.4 Equation for Generated E.M.F

Φ= Flux

Z= Total No. of conductors= total slots x No. of conductors/slot

P = No. of poles

A= No. of paths

N= Rotation in RPM

E= induced e.m.f

E_{avg}= d Φ /dt volts

Whereas d Φ = ΦP

Rotations/sec = N/60

So d Φ/dt= $\Phi PN/60$

No. of series conductors in one parallel path = Z/A

So generated E.M.F is= E_g = $\Phi PN/60$. Z/A

E_g= $\Phi ZN/60.P/A$

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A=P   LAP winding

A=2   WAVE winding

4.9.5 Advantages

The main advantage to use DC generator is that we have to store produced energy to the battery banks before using because the production will not be very consistent to use directly. So using DC generator we don't need to use inverter to store the energy into batteries. There are few more advantages of DC generator are

- Low maintenance
- Light weight
- Low noise
- High quality output
- Low fuel consumption

4.10   Calculation for some Different cases

Average mass of different vehicles like Toyota and Chevrolet is around 1400kg [22]. When it passes across the SB, approximately mass of 350 kg will act on each axle side. If the height of SB is 10 cm. the output will be:

$F=ma=350Kg*9.81m/s^2= 3433.5N$

$W=F.d=3433.5*0.1=343.35J$

Power per second for one pushing force

$P=W/t=357.1/60=5.72W$

If in every 5 seconds 1 vehicles passes over speed breaker

$P/min=5.95*12=68.64W$

In a single minute a vehicle produces that much mechanical stress if we exclude 50% losses we will still get 34.32W in a minute. It will be 2.05 kW for an hour and if this phenomenon happens 12 hours in a day the total amount of produced power will be 24.7KW.

4.10.1 Case 1:

If a bicycle has mass of 40 kg having 29" tires [23] crossing the Speed breaker with velocity of 10km/h and its angular velocity is 7.53rad/sec or 71.92RPM.

Distance travelled=10cm=.1m

Torque=I.α= 3.92Nm   I=moment of inertia

P=Torque x Angular velocity (rad/sec) =29.5W

Power for one pushing force assuming for 1 sec=0.49W

If in every 5 seconds 1 bicycle passes over speed breaker

P/min=5.88

If this phenomena occurs 12 hour in a day the input mechanical stress we get in the form of energy is 4.24KW excluding 50% loses we assume to get 2.12KW electrical power.

4.10.2 Case 2:

If a motorbike has mass of 90 kg having this standard size (130/80-18) tires [24] crossing the Speed breaker with velocity of 10km/h and its angular velocity is 9.4rad/sec or 89.84RPM.

Distance travelled=10cm=.1m

Torque=I.α= 8.83Nm   I=moment of inertia

P=Torque x Angular velocity (rad/sec) =83W

Power for one pushing force assuming for 1 sec=1.38W

If in every 5 seconds 1 bicycle passes over speed breaker

P/min=16.6

If this phenomena occurs 12 hour in a day the input mechanical stress we get in the form of energy is 11.95KW excluding 50% loses we assume to get 5.975KW electrical power.

4.10.3 Case 3:

If an automobile has mass of 350 kg, having this standard size (225/45 R17) tires crossing the Speed breaker with velocity of 10km/h and its angular velocity is 9.867 rad/sec or 94.2RPM.

Distance travelled=10cm=.1m

Torque=I.α= 34.335Nm   I=moment of inertia

P=Torque x Angular velocity (rad/sec) =338.78W

Power for one pushing force assuming for 1 sec=5.64W

If in every 5 seconds 1 bicycle passes over speed breaker

P/min=67.75

If this phenomena occurs 12 hour in a day the input mechanical stress we get in the form of energy is 48.78KW excluding 50% loses we assume to get 24.39KW electrical power.

Table 4.1 Calculations for Different Cases

Source	Mass (kg)	RPM	Force (N)	Torque (Nm)	Input KW (M.P)	Output KW (E.P)	Output Efficiency
Bicycle	40	71.92	392	3.92	4.24	2.12	50%
Motor-Bike	90	89.84	882	8.93	11.95	5.975	50%
Automobile	350	94.2	3430	34.335	48.78	24.39	50%

4.11   Smart Grid

Smart Grid is an Electricity distribution network that is developed by combining Information Technology, Electrical Power System and Communication Technology. It is an impressive 'intelligent' Grid System that's why it is called Smart Power Grid or Smart Grid.

A Smart Grid is an advanced grid system that is capable to handle the electricity demand manner, authentic economic manner and developed on innovative structure.
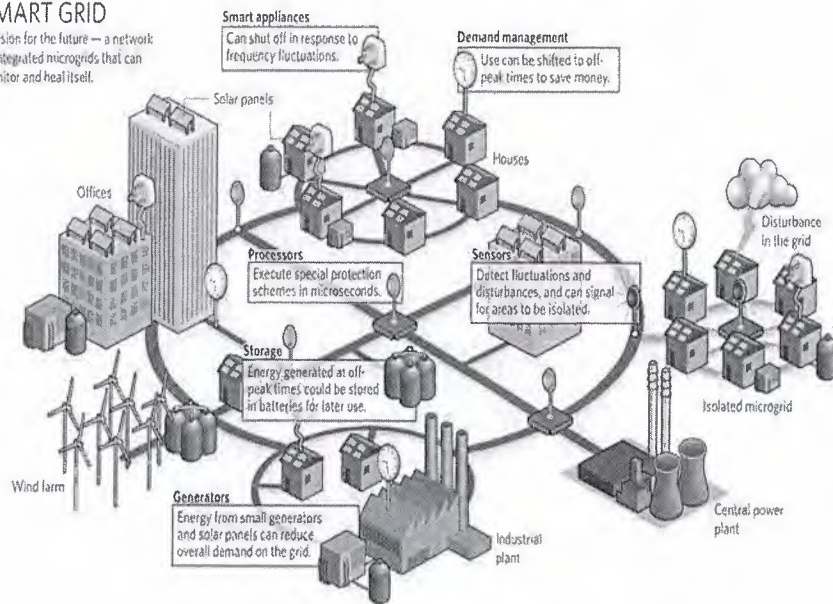
Figure 4.13 Smart grid [26]

4.11.1 Features

- It has capability to recover itself.
- It encourages the user to take part in the operation as it uses the two way communication system so the energy has been supplied according to the requirement
- It is more reliable in terms of outages.
- The main advantage of SG is automation technology that facilitates the centre to control any device or million of devices from one place.

4.12 Summary

In this chapter we briefly discussed about speed breaker, rack and pinion, shaft, spur gears, alternator and smart grid. All the calculation has been done according to our input mechanical energy. Few different cases have been also discussed to see variation in output.

CHAPTER 5

AUTOMOBILE MOTIVE POWER CONVERTER

5.1 Overview

This chapter comprises on the simulink model of our proposed system in MATLAB. System has been divided in six modules and each module explained briefly. These modules are automobile's module, rack-pinion module, gear module, alternator module, DC-AC module and smart grid module. output results has been taken in the form of graphs in MATLAB.

5.2 AMPC MATLAB Simulink Model

In renewable energy resources automobile motive power converter has also significant place. It can also have substantial importance in industrial sector. Electricity produced by Automobile motive power converter (AMPC) can be distributed using DG system (Distribution Generation System) if smart grid conduction and distribution expenses are out of range. In this chapter simulink model of AMPC is explained.

We used MATLAB 2013 software to build this simulink model. This software can be used to build plenty of applications model. It contains many built in blocks to perform many tasks which makes the work so easy and makes it more users friendly. It offers all the facilities to complete our simulink model. We divided our simulink model into few sections to make its understanding easier.
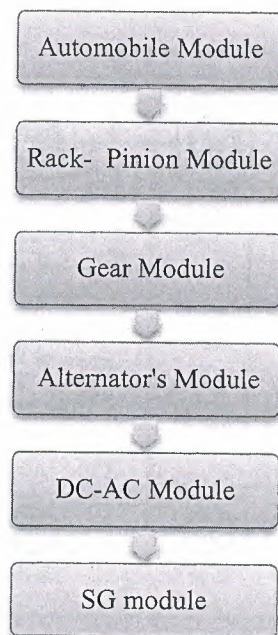
Figure 5.1 AMPC simulink model block diagram

5.3 Model Explanation

This simulink model has been divided into 6 sections explained below

5.3.1 Automobile module

The first module is automobile module that consists of Gasoline engine with throttle control. Then with regards to fabrication a Drive line Environment is connected. A pair of differential shafts are attached with drive line environment, 1 is for backside tires and second is for front side tires. 1 drive shaft is connected to engine block also. The tires are named as RR, RL, FR and FL (Rear right, Rear left, Front right, Front left). The tires are connected to vehicle block to perform the tasks like RPM and automobile's velocity
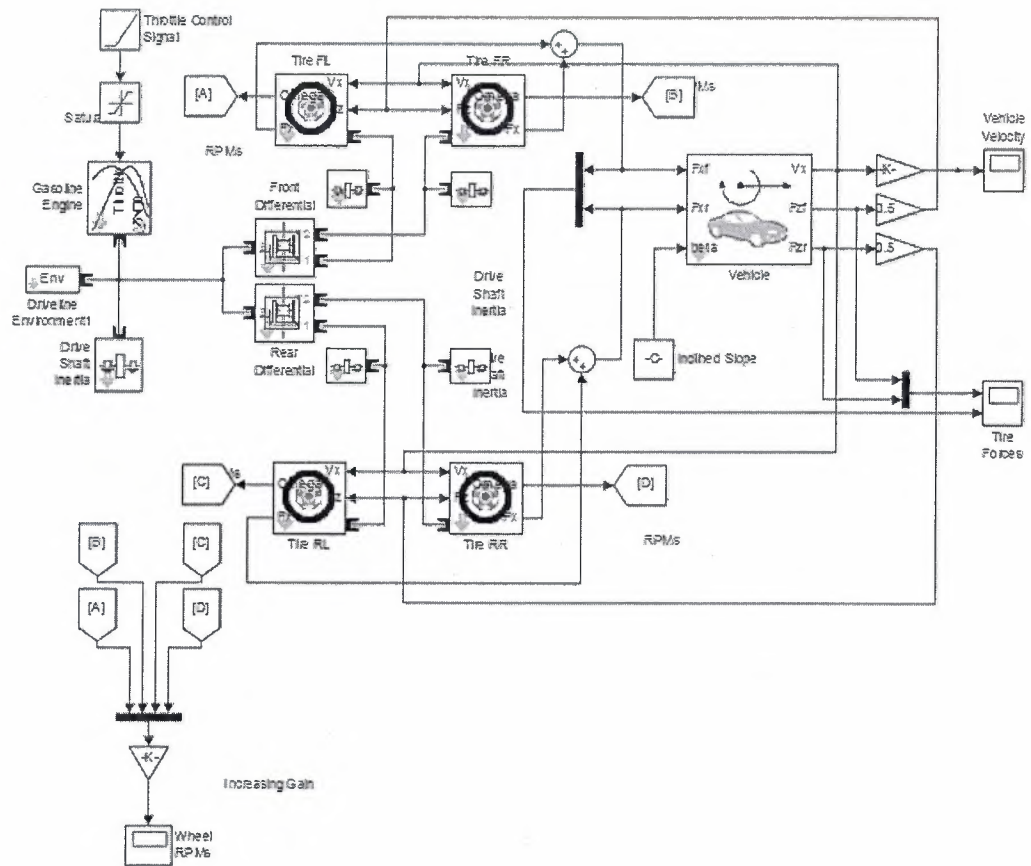
Figure 5.2 Automobile module

5.3.2 Rack-Pinion module

The second one is related to the rack and pinion arrangement. It contains a block named solver configuration as requirement to perform the function. The input signal which we get from the previous automobile sections is transformed to the physical signal from the simulink signal. A translational friction block is also added in the model as tires exert friction force on the speed breaker. The damper block associated with velocity source presents SB and lessens the automobile speed up to required value. Translational motion sensor has been added to act as rack and the output we get is again converted to simulink signal from physical signal. Spring task is to reload the system.
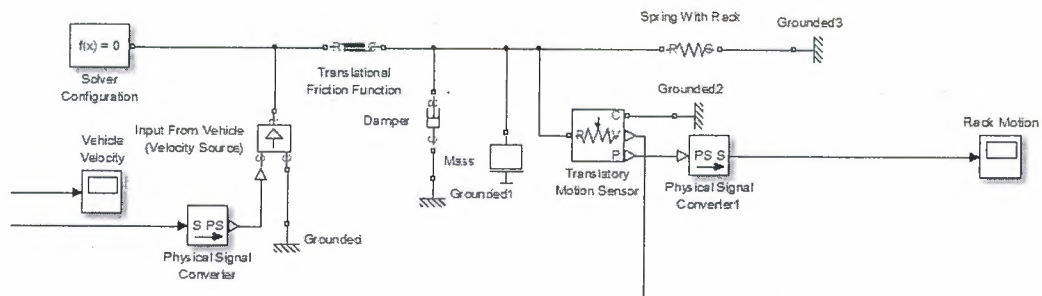
Figure 5.3 Rack module

5.3.3 Gear module

In this section the translational motion is converted to rotational motion with the help of a converter after that one motion sensor is connected to recognize the motion. A drive line environment is connected before the gear arrangements. There are two gears are attached 1 called simple gear and the other is variable gear. first one is used to rotate the variable gear on the other shaft as it is shown in our mechanical diagram. It can be simple 1-1 ratio. Variable gear is used to vary the speed as our requirement for the input of alternator. Motion sensor is attached to both gears to see the difference in the rotation of both. Flywheel is used to get over the jerks its output is also shown in graph.
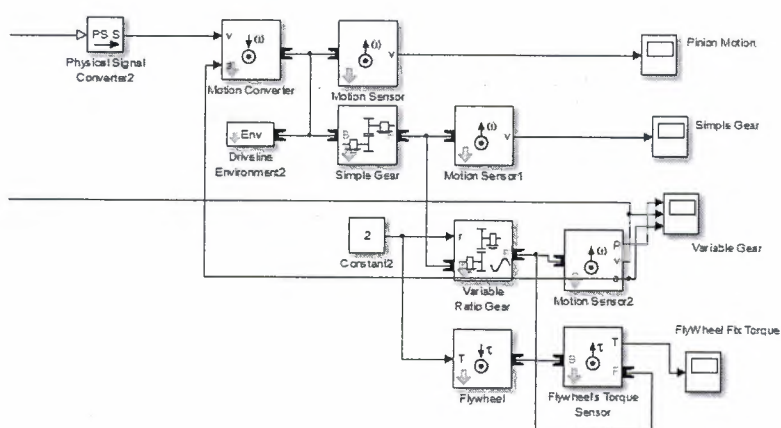
Figure 5.4 Gear module

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5.3.4 Alternator module

After the gear section the next process is to run the alternator to generate the electricity. The output from the variable gear section is used as input of the alternator section. DC alternator is used here. Volt meter and Ampere meter is also connected at the output of the alternator to check voltage and current. Graphs of all the characteristics of alternator are also shown later.
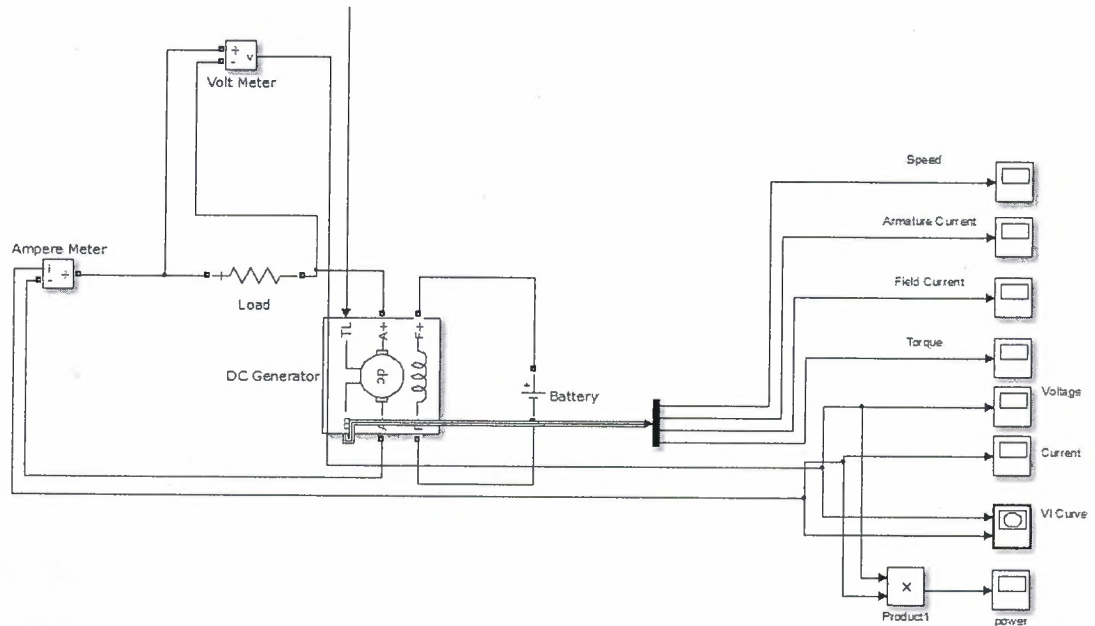
Figure 5.5 Generator module

5.3.5 DC-AC module

This section converts DC to three phases AC by using the IGBT universal bridge named as Vsc2 block. It takes DC input and converts it to the 3 phase AC. Voltage regulator named as 'Vsc2 Control' and Discrete PWM generator is used for the gate 'g' input of the universal bridge. LC filter and Measurement blocks are used to purify and measure the output respectively. Three phases output result has been generated as graph using scope.
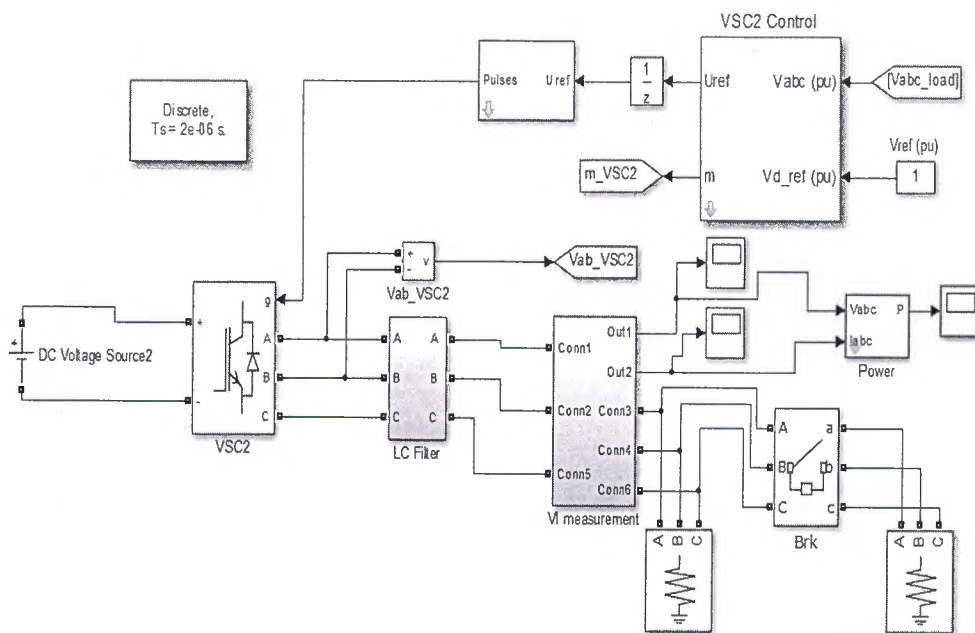
Figure 5.6 DC-AC module

5.3.6 SG module

The last section is about Grid unit. In this section transformer is used to transform 3 phase to electricity to user end. A three phase harmonic filter is also connected to transmission lines managed by SF6CB. Blocks are connected to find active and reactive power at user's end. A three phase meter is also used to monitor the dispersion in between users.
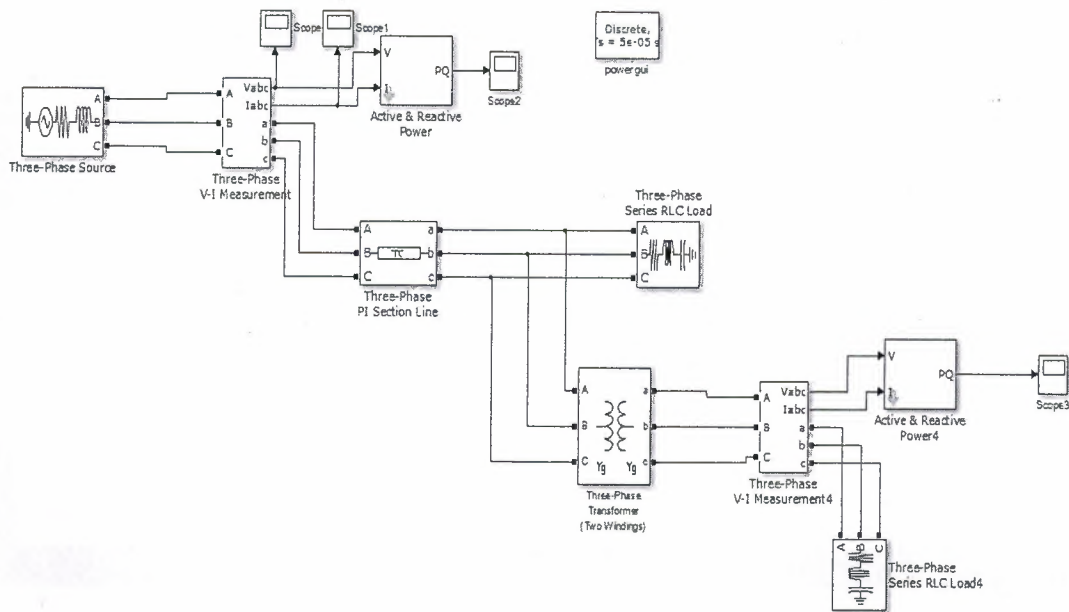
Figure 5.7 SG module

All the output graphs have been shown in next section. All these graphs have been taken by one time evaluation of the system. In other words we can say we took the output of 1 vehicle passing through SB.

5.4 Output Graphs

This graph shows the vehicle's speed that is around 10kph according to our requirement.
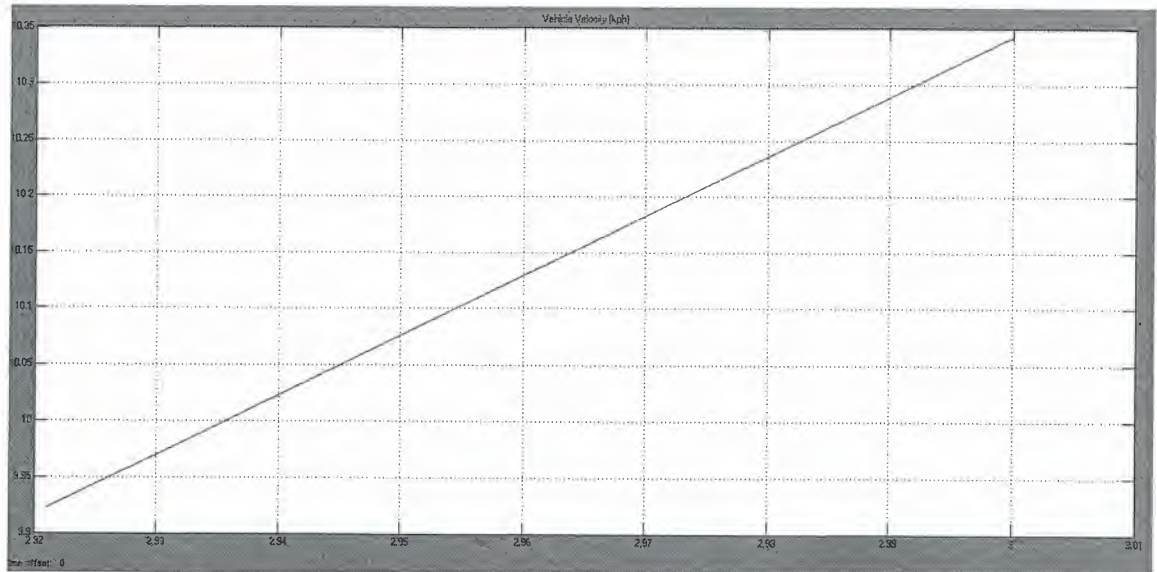
Figure 5.8 Velocity of automobile

This graph is showing vertical and horizontal frictional force on tires from road.
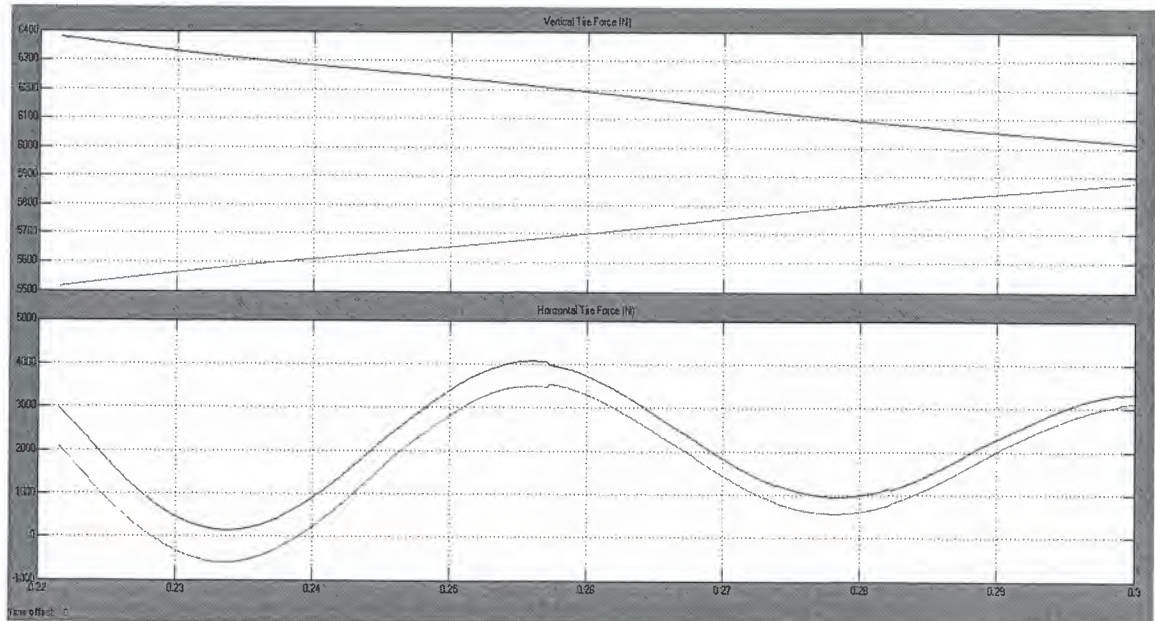
Figure 5.9 Tire's force

46

This graph is about RPM, we get from vehicle's wheels. That should be around 94RPM and from the graph we can see that its almost the same.
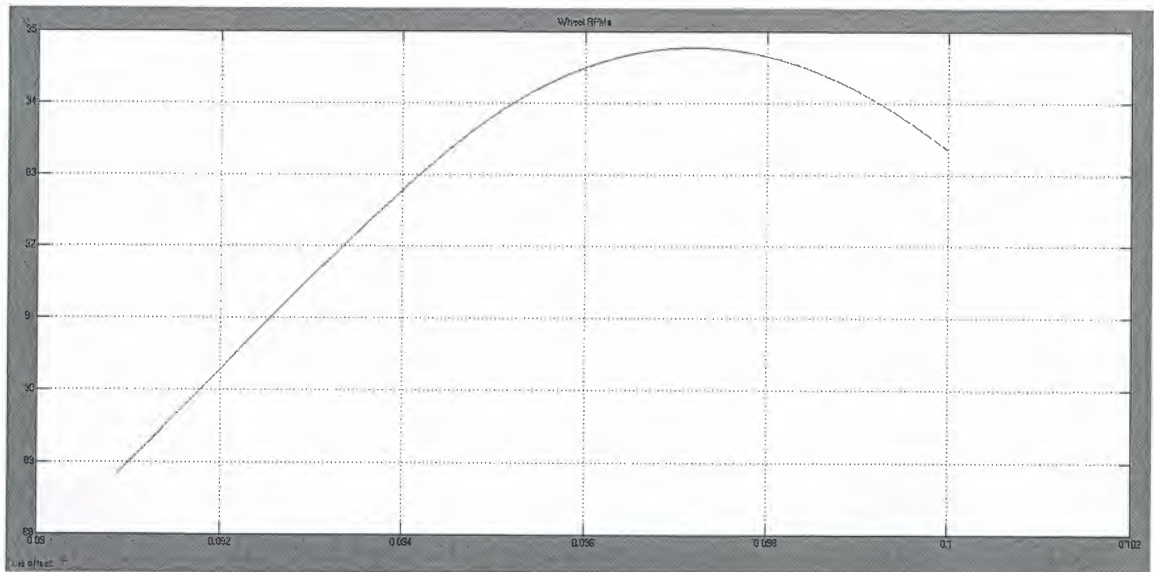
Figure 5.10 RPM of wheel

This graph is showing the displacement of the rack from its initial position.
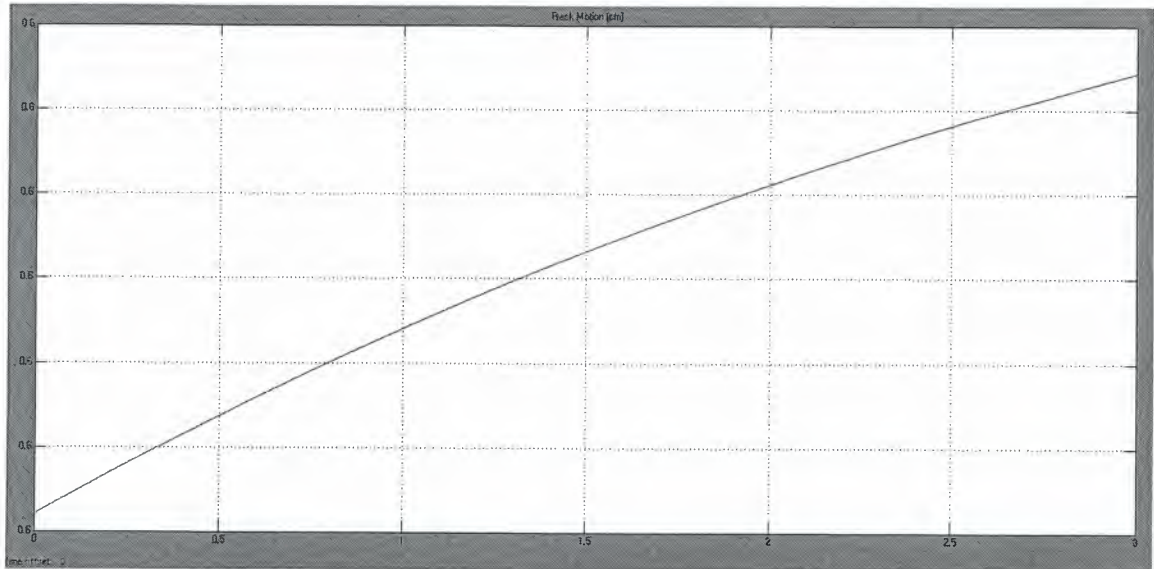
Figure 5.11 Movement of rack

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The graph below is showing movement of pinion attached to rack.
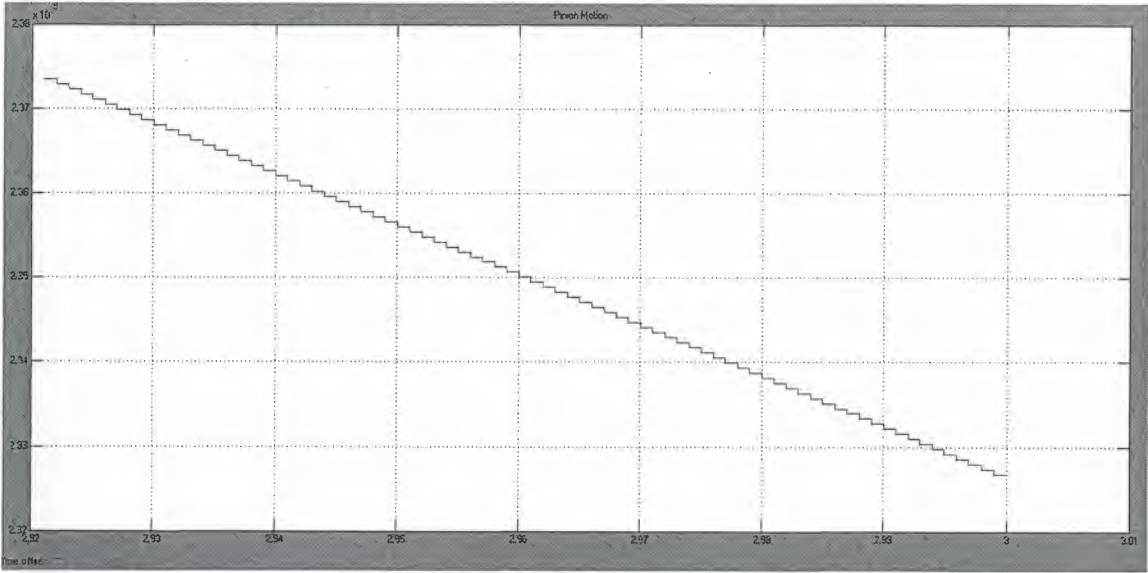
Figure 5.12 Movement of pinion

Figure 5.13 is showing the simple gear output that is acting as a chain sprocket. It is constant.

Figure 5.13 Simple gear

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The following graphs is represnting variable gear position, velocity and accerlation. Its output velocity is around 2000 RPM that is approximately equal to our calculations.
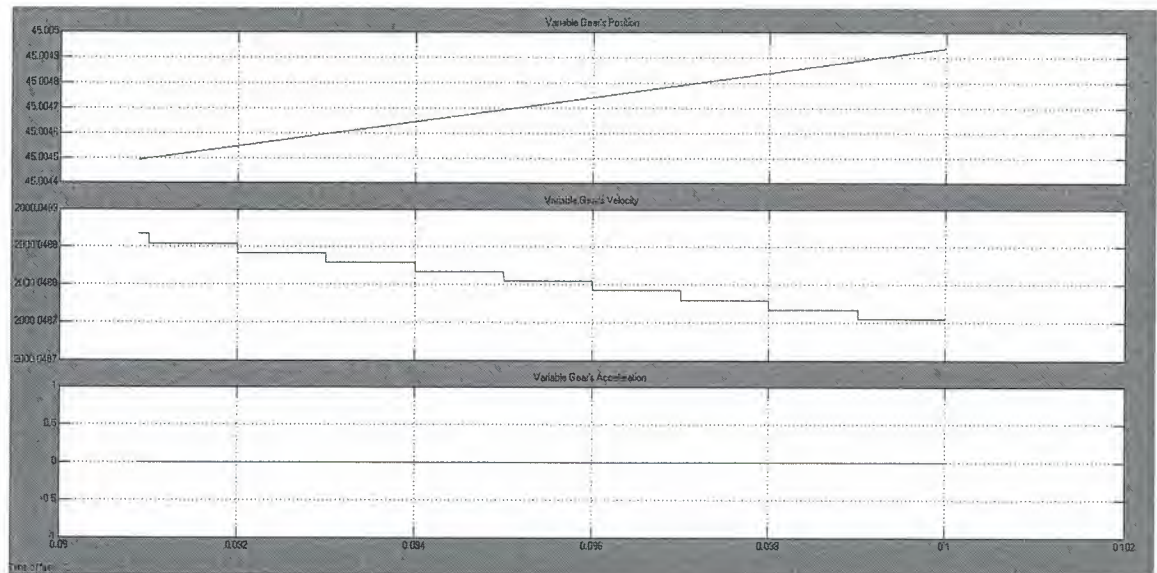

Figure 5.14 Variable gear

This graph is showing torque generated by the flywheel. That is also constant because it absorbs the jerks and gives constant output.
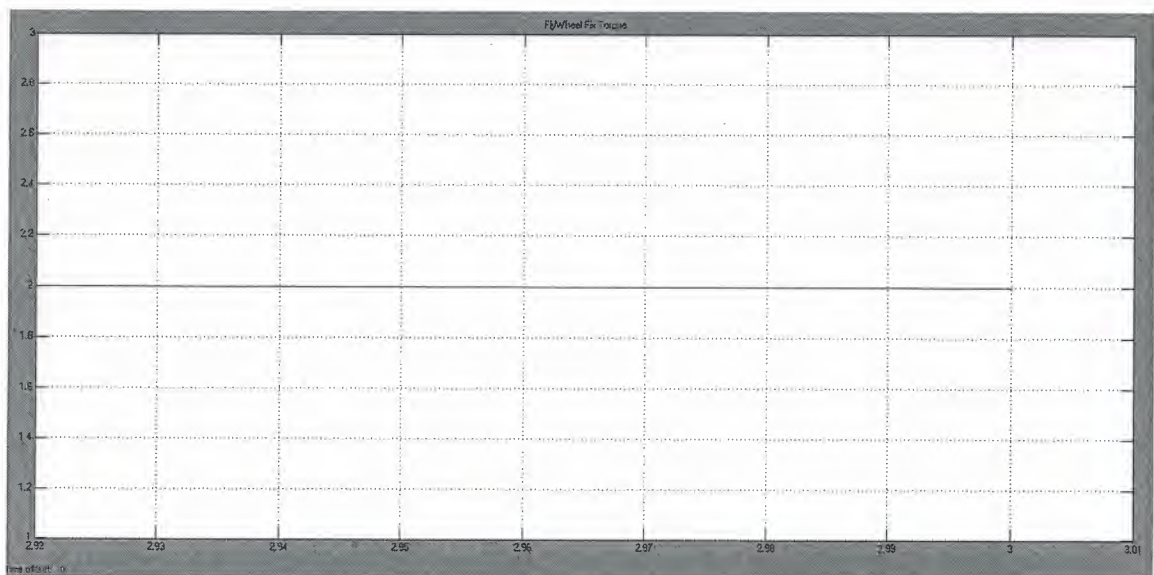

Figure 5.15 Flywheel's torque

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Figure 5.16 is the output from the DC generator block that gives us speed of alternator.
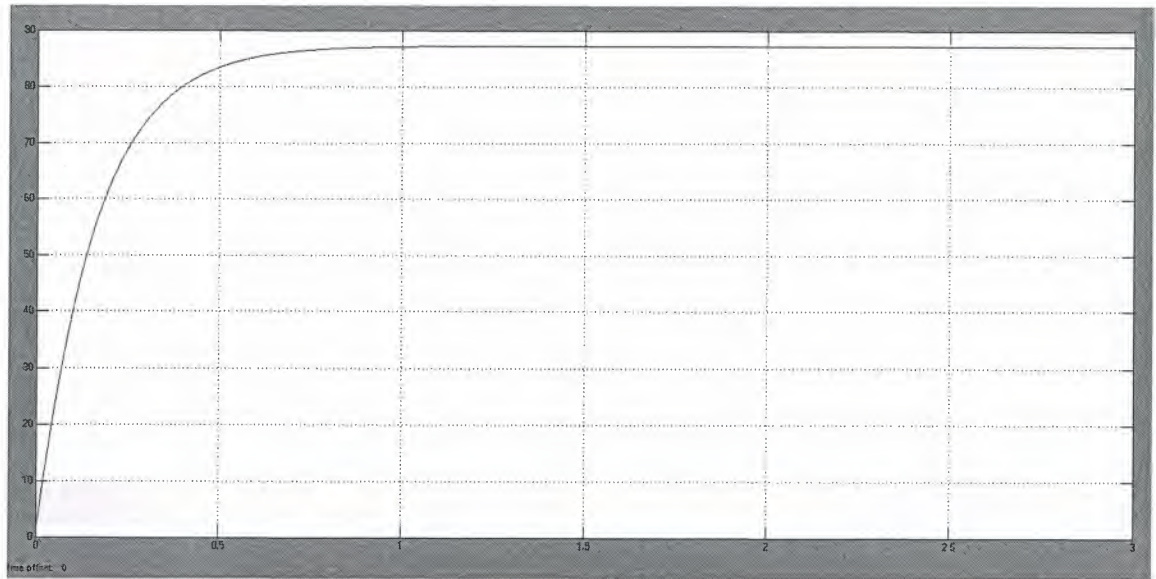

Figure 5.16 Speed of alternator

This following graph is about the current flowing in armature. This graph is also an output taken from generator block.
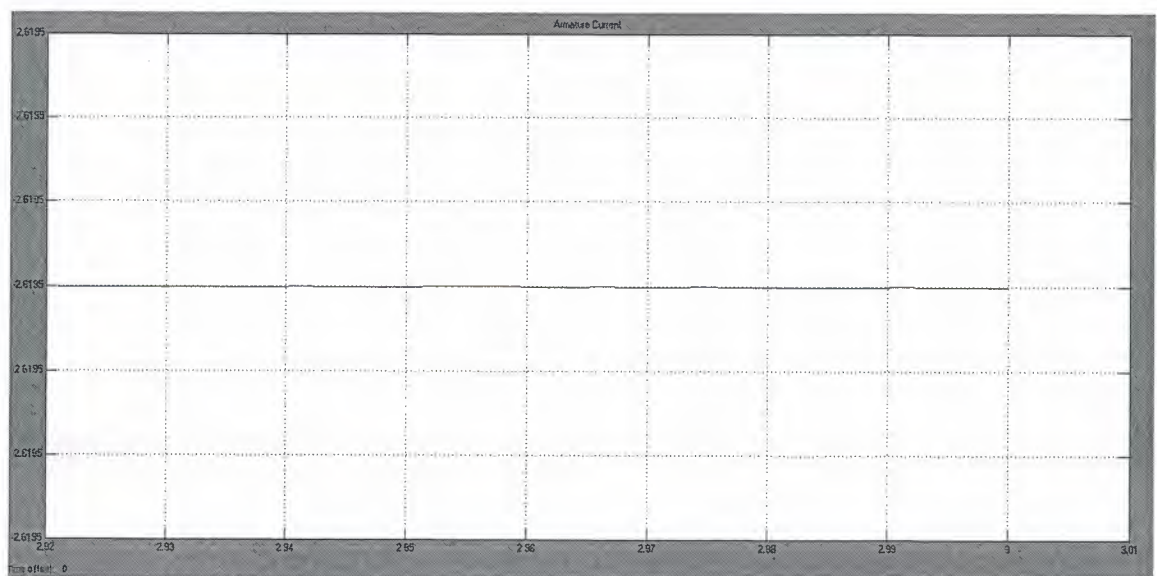

Figure 5.17 Current in armature

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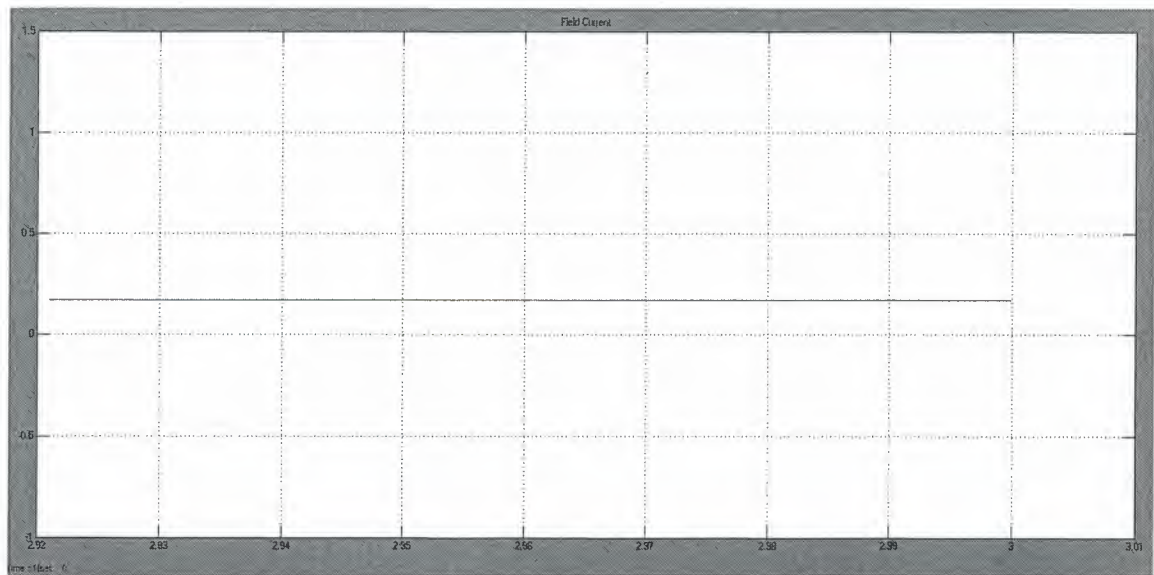Field's current in generator has been showed in the following graph.

Figure 5.18 Field's current

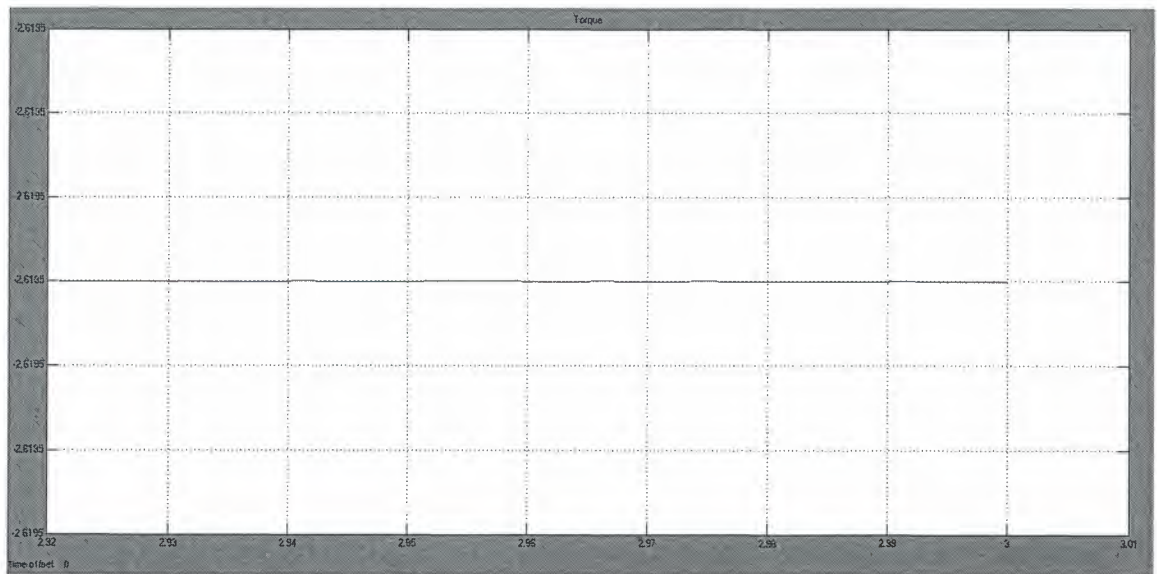Torque produced by the generator has been showed in the graph below.

Figure 5.19 Generator's torque

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This following graph is showing DC output voltage generated by the system.
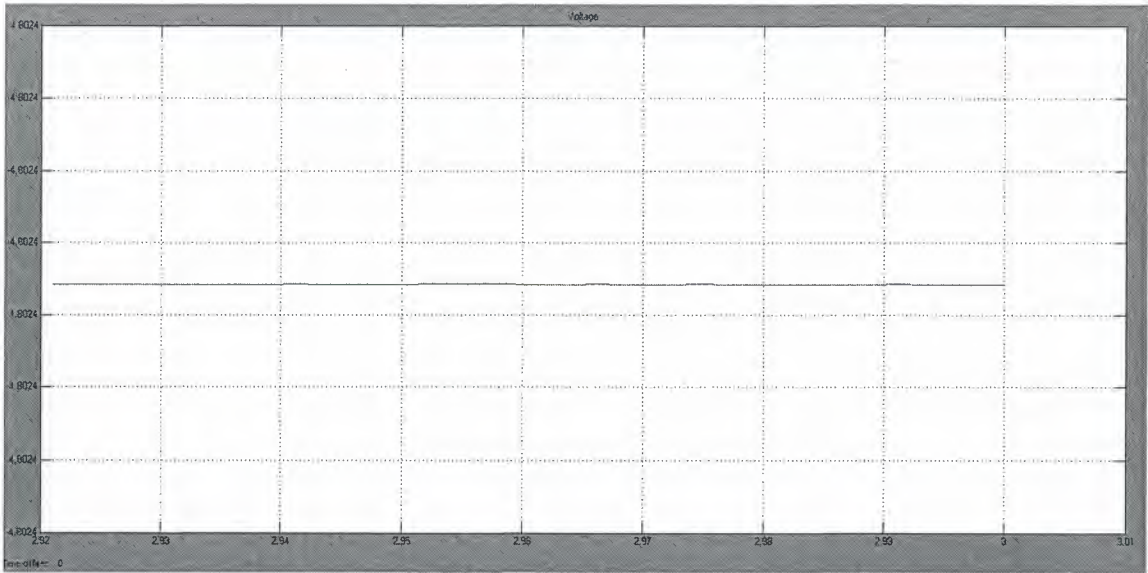

Figure 5.20 DC output voltage

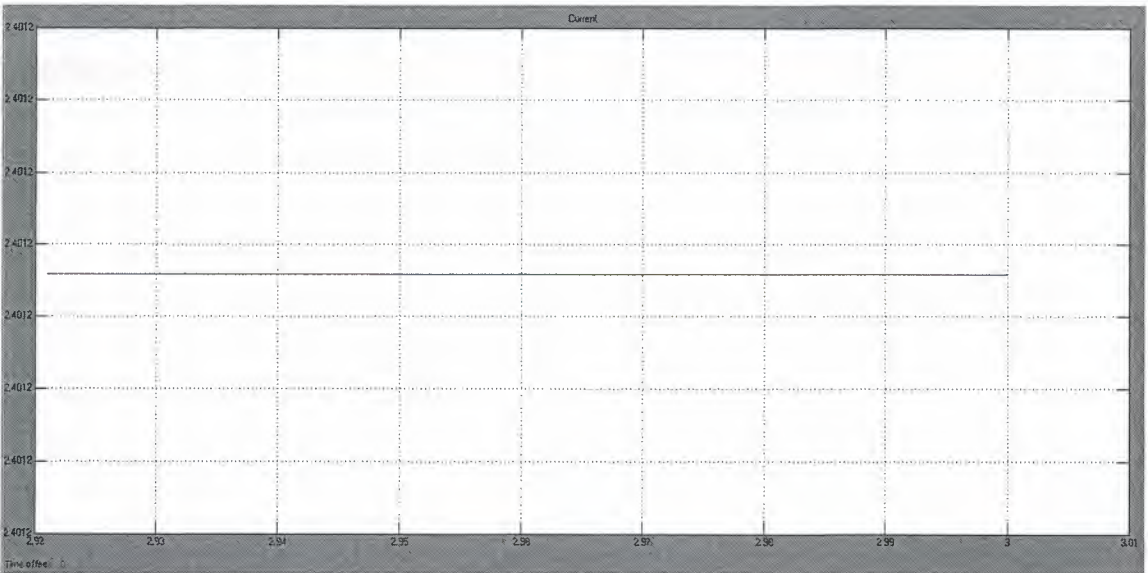This following graph is showing DC output current generated by the system.

Figure 5.21 DC output current

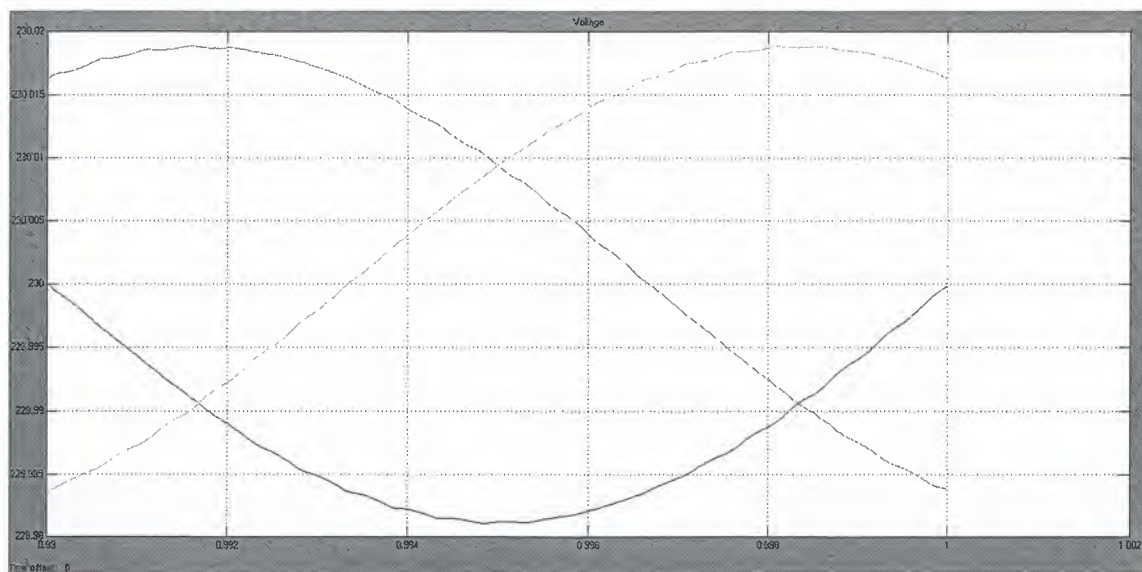After converting DC into Three phases AC we got the following three phase voltage output.

Figure 5.22 Three phase voltage

The 3-phase current we got after conversion has been shown in the graph below.
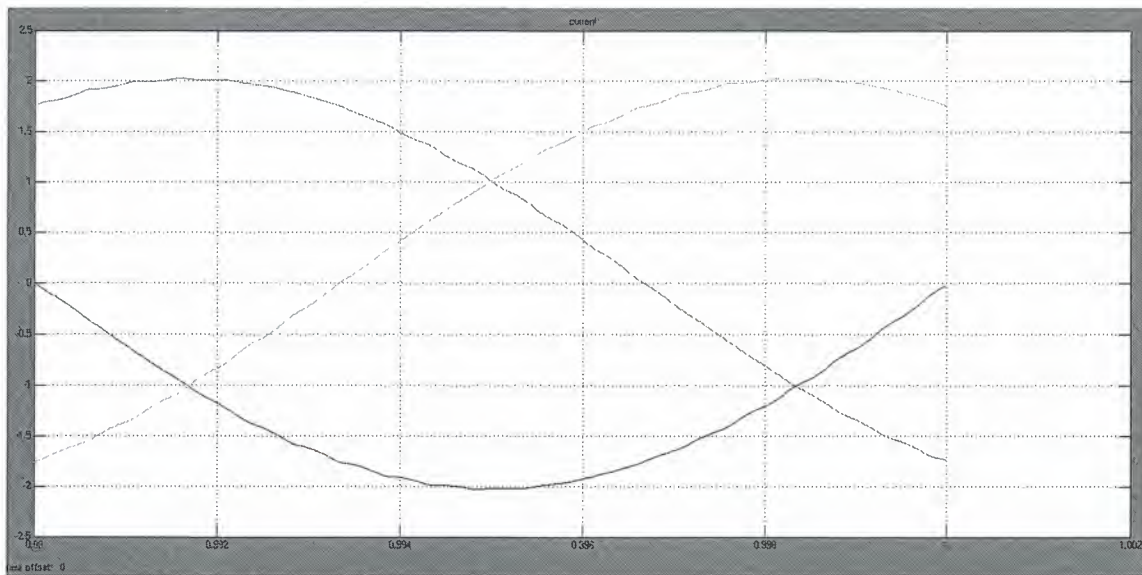

Figure 5.23 Three phase current

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The following graph is showing the power of three phase signal.
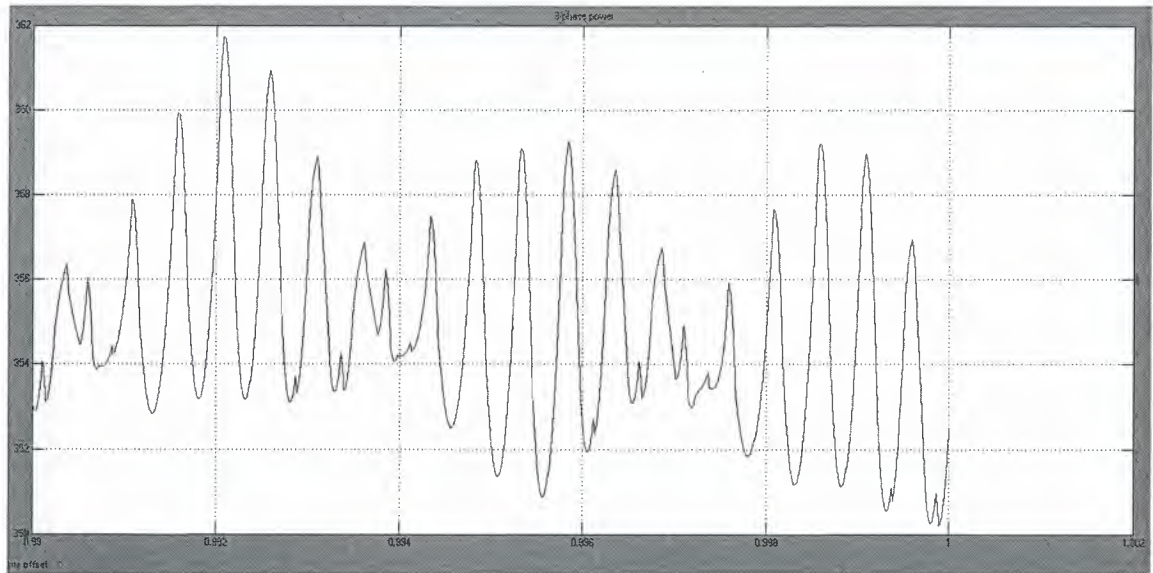

Figure 5.24 Three phase signal power

The graph below is showing the active and reactive power from the transmission lines in the grid module.
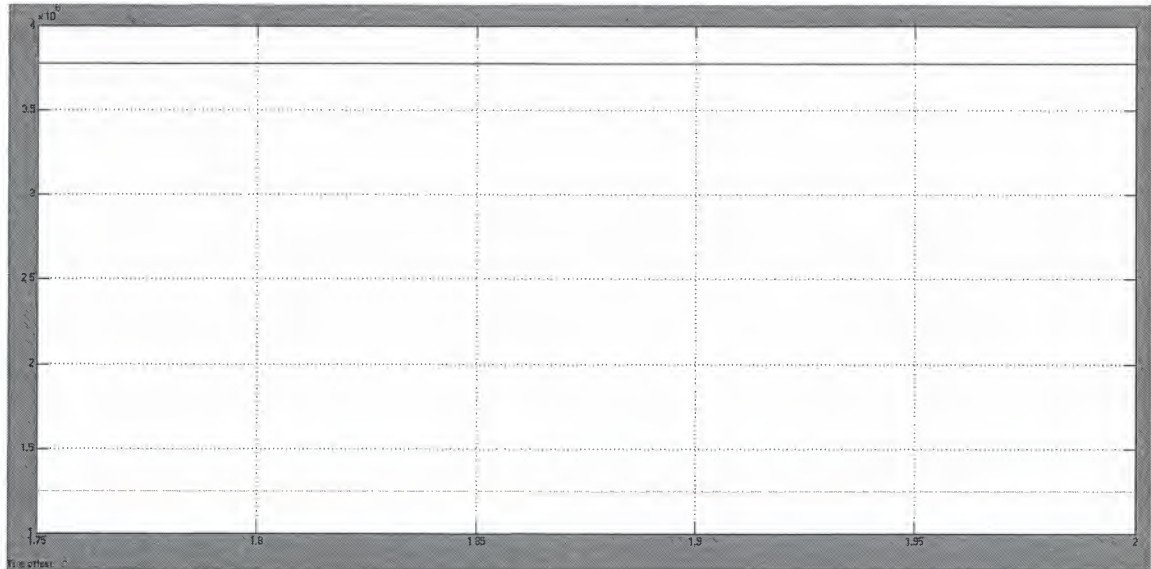
Figure 5.25 Active and reactive power

This follwing graph is about the output DC power we get from the system.
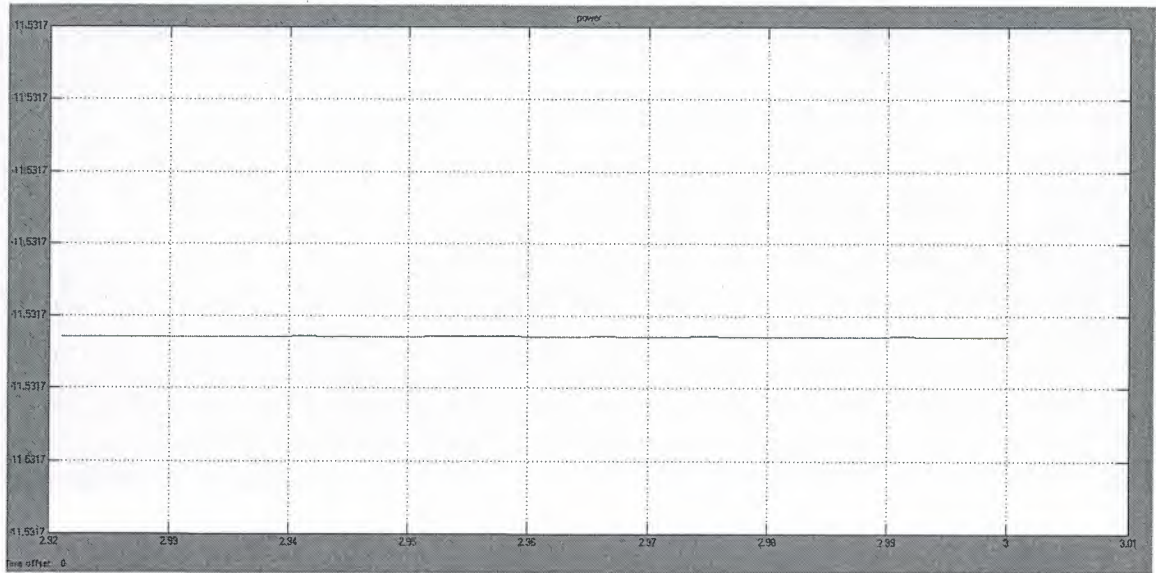
Figure 5.26 DC power output

5.5 AMPC Real-time Simulation Model in 3ds MAX 7

AMPC real-time simulation has been showed in the following pictures. In the first picture it has been shown that automobile is coming towards SB. In second one automobile is passing over the SB and we can see the change in position of mechanical arrangement and in the 3rd shows that vehicle has passed, electricity generated in that cycle and system reloaded.

Figure 5.27 Automobile coming to SB

Figure 5.28 Automobile crossing over SB position change in arrangement

Figure 5.29 Electricity generated and system reloaded

5.6 Discussion

The design of our proposed system has been showed in figure 5.27. Specifications of all parts of proposed system has been explained in chapter 4. Figure5.27 shows that an automobile is crossing over th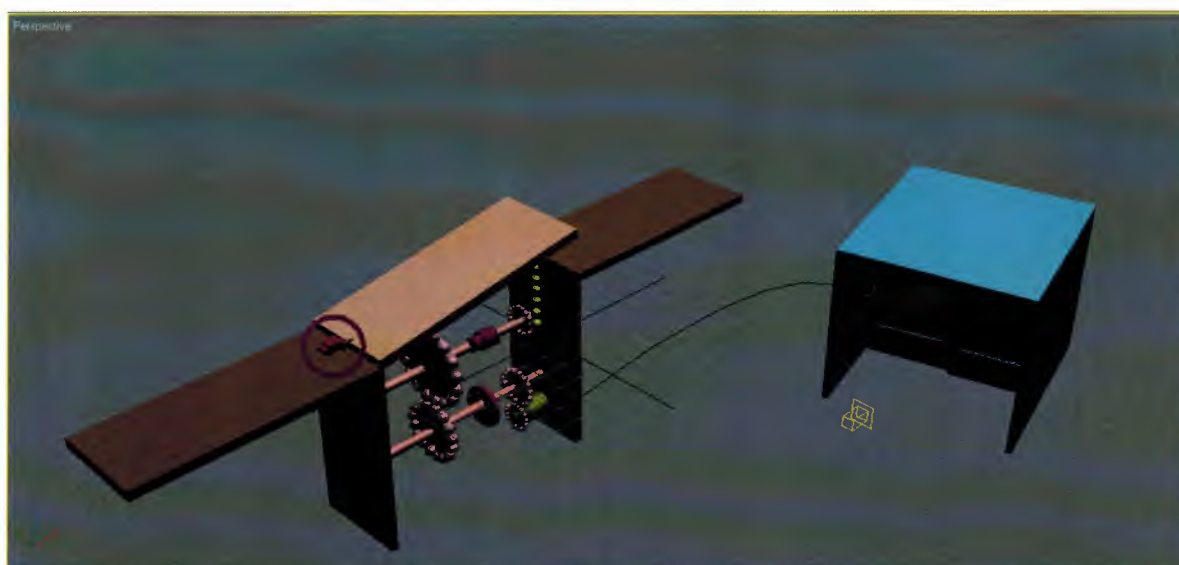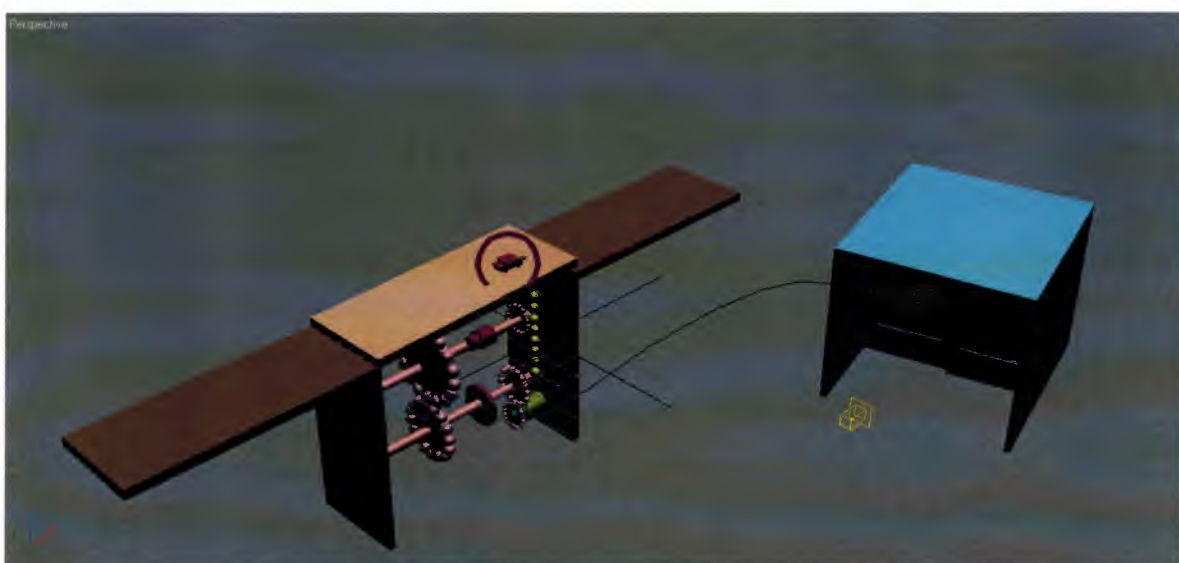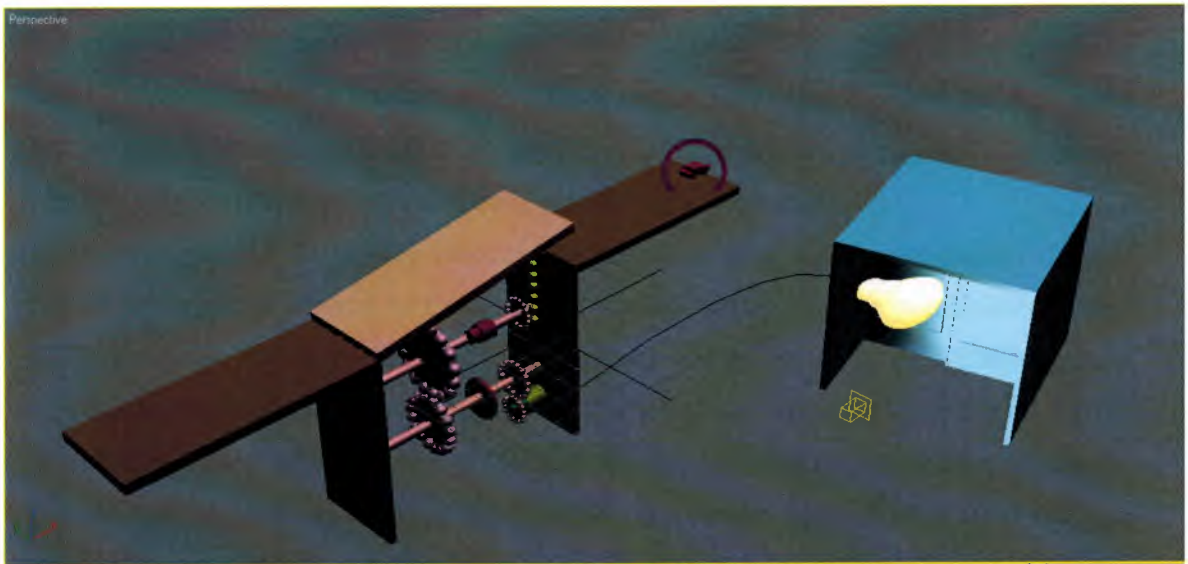e speed breaker. We can see the contact between automobile's tires and surface of speed breaker. When automobile comes over the speed breaker it causes movement in the speed breaker arrangement. It moves the rack down (can be seen in Figure 5.28), that rotates the pinion after that pinion rotates the sprockets on common shaft that causes rotation in the gear which moves the alternator at the end electricity is generated (Figure 5.29). Table 2.1 shows the comparative study of old researches and its output results. After comparing we can notice that our system is more efficient in terms of output we get. Table 4.1 shows the calculations for different cases output (Electrical energy) comparatively to the input (Mechanical energy). From the table we can see that when automobile's weight increases it results the increase in the output. Figure 5.20 shows the output DC voltage that is approximately 4.80V in one cycle; Figure 5.21 shows the output current that is approximately 2.40A in single cycle and figure 5.24 shows the output power that is approximately 11.53W in a cycle. If we assume 50% losses the output power will be 5.76W. This output power is approximately equal to the output

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power we calculated for one cycle in table 4.1 (i.e 5.64W≈5.76W). This generated voltage will be stored in batteries for further use. These results are of single system and one cycle but we can increase the efficiency by installing multiple systems in parallel. The energy generated by the proposed system is quite sufficient for small loads.

In graphs Figure 5.8 is showing velocity of vehicle that is approximately around 10 kph. Figure 5.9 is about vertical and horizontal tires forces respectively. Automobile's tires RPM has been shown in Figure 5.10 it is between 94 RPM to 95 RPM which is approximately equal to our calculation that was 94.2 RPM. Figure 5.11 and Figure 5.12 is showing movement or Rack and Pinion respectively. Figure 5.13 is representing simple gear movement that is working as sprocket to connect both shafts. Velocity and acceleration of variable gear has been shown in Figure 5.14, in this figure we see the gear's output velocity is 2000.04 RPM it is approximately equal to our calculated output that was 2000.34 RPM.

Figure 5.15 and 5.16 are about flywheel torque and speed of alternator respectively. Whereas Figure 5.17 is about armature current of alternator and 5.18 is showing field current produced by alternator. Figure 5.19 is representing torque produced by alternator. As explained before about figure 5.20 and 5.21 are output DC voltage and DC current respectively. In the last step we converted DC to AC to transfer to the grid so the Figures 5.22 and 5.23 are showing 3-phase voltage and current respectively. Figure 5.24 is showing active and reactive power of 3-pahse signal and Figure 5.25 is about 3-phase signal power. In the end Figure 5.26 is representing DC power output of the system.

5.7 Summary

Simulink model has been discussed of our proposed system in this chapter step by step. Output results have been also taken using MATLAB. All these output graphs has been discussed also. These output graphs values are also approximately equal to our estimated values. After comparison we see that output results are almost equal to our estimated output.

CHAPTER 6
CONCLUSION AND FUTURE WORK

6.1 Conclusion

In this thesis the analytical simulink model of Automobile Motive Power Converter is described. This work gave us idea of a source to produce electricity in our daily routine life. To fulfill the increasing demand of electricity as the population has been increasing this kind of alternative sources can be very helpful and we can use the conventional sources to fulfill other needs of men. This system is very useful to generate electricity by utilizing energy lost by automobiles on speed breakers. It has been noticed from the thesis is the AMPC system's efficiency is dependent on speed of automobile, number of automobiles passing over speed breaker with rate of time and proper mechanical arrangement. The automobiles with low speed exert more force on the speed breaker by its tires and give high efficiency whereas automobiles with high speed exert less force on the speed breaker by its tires and give less efficiency. AMPC system is economical and reliable. This system can be implemented at the places where the automobile's speed must be low like parking of Shopping centers, fueling stations or in front of schools and Toll tax plazas. After implementation the only cost will be the maintenance cost as there is no cost for fuel to run the system. The power generated by the system is totally pollution free and can produce power throughout the year. This thesis represents the design of system having output 24.7 KW/day in MATLAB Simulink software. To make this system easy to understand a real-time simulation using 3d max is also done. The generated electricity can be used to illuminate nearby buildings or to illuminate street lights or to charge electric cars and batteries. This can help to save a lot of power that is being used to illuminate the street lights. There is always some capacity to improve in every system we can make our system more efficient also by designing it for high weight with high capacity generator.

6.2 Future Work

Every system or inventions always have margin for improvement. There are few things that can be done to improve the proposed system. The first one is we proposed ratchet system that stops the gear and alternator to rotate in the reverse direction when rack moves upward to its initial position. If we find any applicable mechanical arrangement technique to rotate the gear and alternator arrangement in same direction either the rack moves downward or upward the system will be more efficient.

The second one is that if we design the rack for heavy vehicles in that style that it can rotate two gear arrangements simultaneously. It can help to enhance the generation. The following picture shows that type of arrangement.
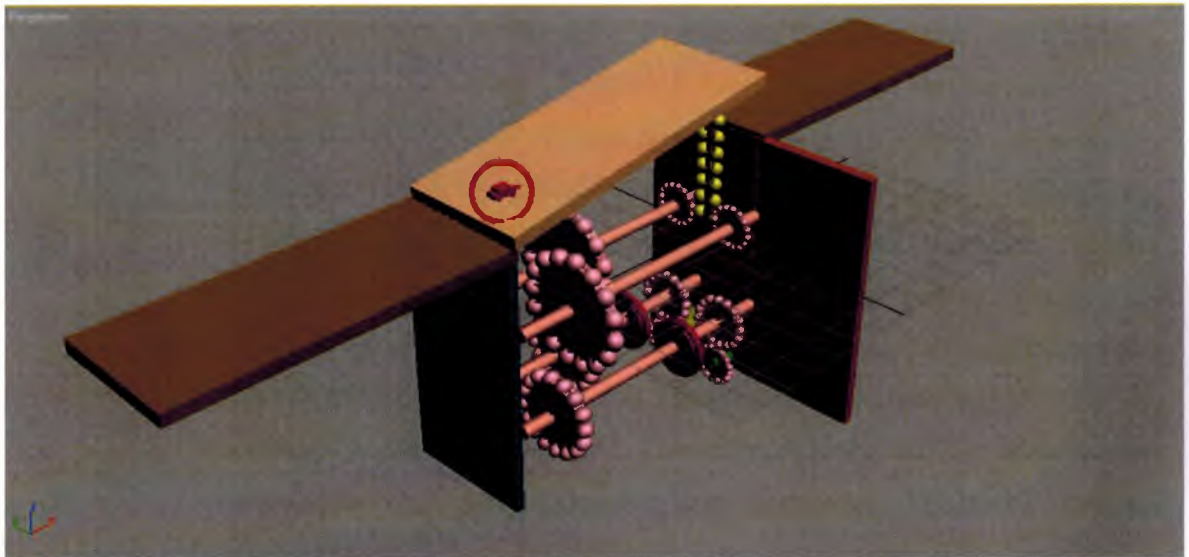

Figure 6.1 Rack with 2 pinions

Instead of batteries we can use super capacitor or ultra-capacitor also. It is basically a device that covers the gap between electrochemical capacitor and batteries. It can store almost 10 times more energy per unit volume comparatively to old electrolytic capacitors. It has much faster charging time than the rechargeable batteries.

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