A REPORT ON

"Power Generation Through Gym Equipment"

Submitted in partial fulfillment of the requirements of,
Bachelor of Engineering in
Electrical Engineering.
2018-19

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I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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PREFACE

We take the opportunity to present this report **—"POWER GENERATION THROUGH GYM EQUIPMENT".** The object of this report is to make a POWER GENERATION THROUGHT GYM EQUIPMENT with low cost.

The report is supported by images to bring out the purpose and message. We have made sincere attempts and taken every care to present this report in precise and compact form, the language being as simple as possible.

The task of completion of the project though being difficulty was made quite simple, interesting and successful due to deep involvement and complete dedication of our group members.

ABSTRACT

Man has needed and used energy at an increasing rate for his sustenance and well-being ever since he came on earth for few million year ago. Due to this lot of energy resources have been exhausted and wasted. Proposal for the utilization of waste energy of power generation by gym pulley is very much relevant and important for highly populated countries like India and china the people are crazy about gym. In this project we are generating electrical power as non-conventional method by simply pull up and pull down. Non-conventional energy system is very essential at this time to our nation. Non-conventional energy using ABS WORKOUT MACHINE converting mechanical energy into electrical energy. In this project the conversion of force energy into electrical energy. The use of human-power in more efficient manner for generation has been possible due to modern technology. ABS WORKOUT MACHINE is an excellent source of energy, 95 percentage of the exertion put into ABS WORKOUT MACHINE power converted into energy. A human-powered electricity generation has been unveiled by company. In this apparatus, the user has to do the ABS workout from the gym equipment for generating power.

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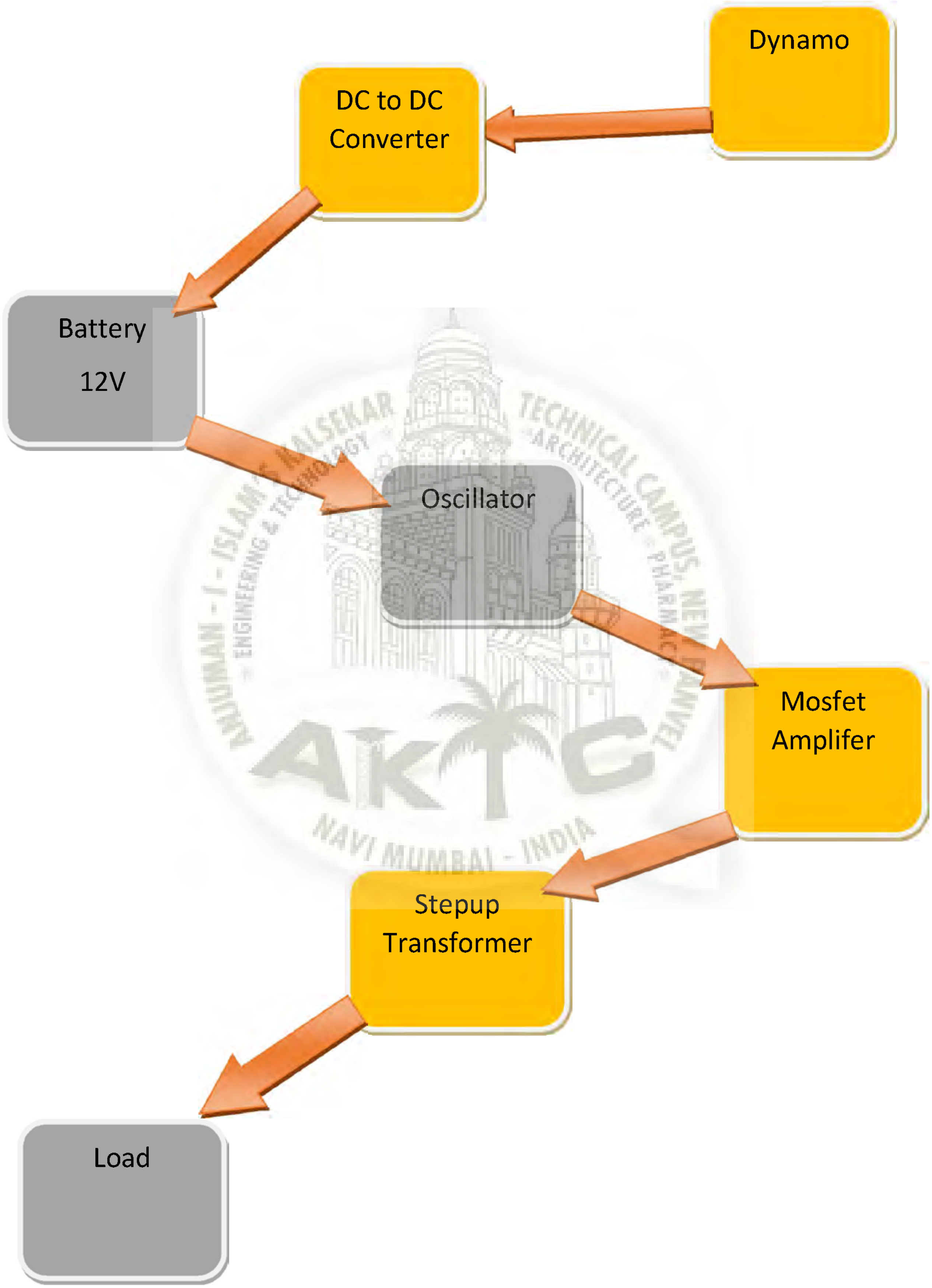
Chapter 1

1. Introduction

ABS WORKOUT power is the transfer of energy from a human source through the use of rack and pinion system. This technology is most commonly used for gym centre or house .less commonly gym power is used to power agricultural and hand tools and even to generate electricity. Some application include battery charge home appliance. The articles on this page are about the many wonderful application for power generation by gym pulley technology. Whenever the person is allowed to pass over the gym pull up pull down. As the spring are attached to gym equipment's, they get compressed and the rack, which is attached to, the bottom of the rod moves down reciprocating motion of rack in to rotary with certain RPM these shafts are connected through a chain drive to the dynamos, which converts the mechanical energy into electrical energy.

Chapter 2

2.1 Block diagram



2.2 Dynamo

A dynamo is an electrical generator that creates direct current using a commutator. Dynamos were the first electrical generators capable of delivering power for industry, and the foundation upon which many other later electric-power conversion devices were based, including the electric motor, the alternating-current alternator, and the rotary converter. Today, the simpler alternator dominates large scale power generation, for efficiency, reliability and cost reasons. A dynamo has the disadvantages of a mechanical commutator. Also, converting alternating to direct current using power rectification devices (such as vacuum tubes or more recently via solid state technology) is effective and usually economical.

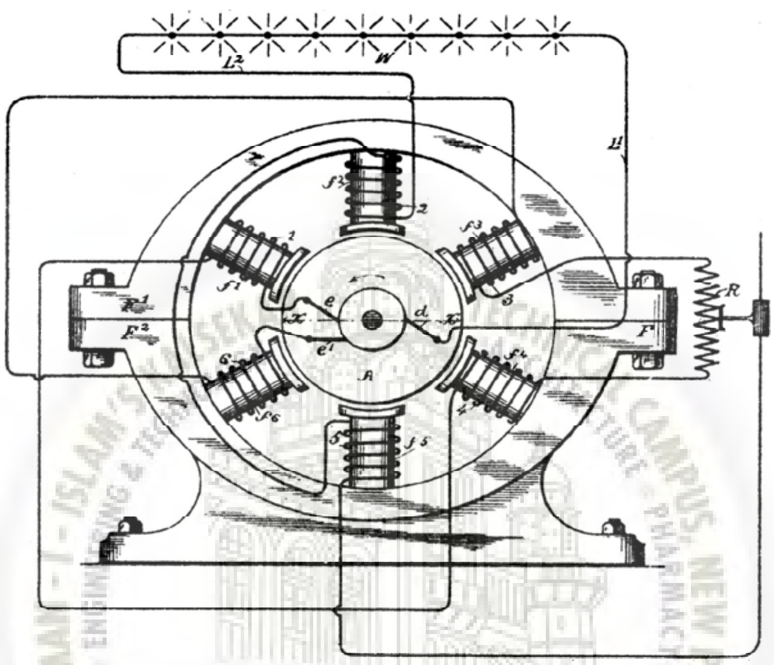


Fig. 1. Dynamo

2.3 Bridge Rectifier

Bridge rectifiers are in the same class of electronics as half-wave rectifiers and full-wave rectifiers. Figure shows such a bridge rectifier composed of four diodes D_1, D_2, D_3 and D_4 in which the input is supplied across two terminals A and B in the figure while the output is collected across the load resistor R_L connected between the terminals C and D.

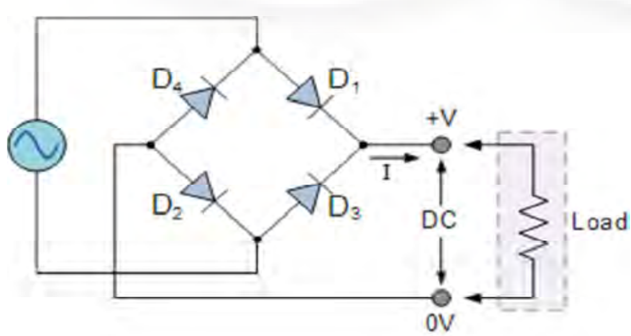


Fig. 2. Bridge Rectifier

Now consider the case wherein the positive pulse appears at the AC input i.e. the terminal A is positive while the terminal B is negative. This causes the diodes D_1 and D_3 to get forward biased and at the same time, the diodes D_2 and D_4 will be reverse biased.

As a result, the current flows along the short-circuited path created by the diodes D_1 and D_3 (considering the diodes to be ideal), as shown by Figure 2a. Thus the voltage developed across the load resistor R_L will be positive towards the end connected to terminal D and negative at the end connected to the terminal C.

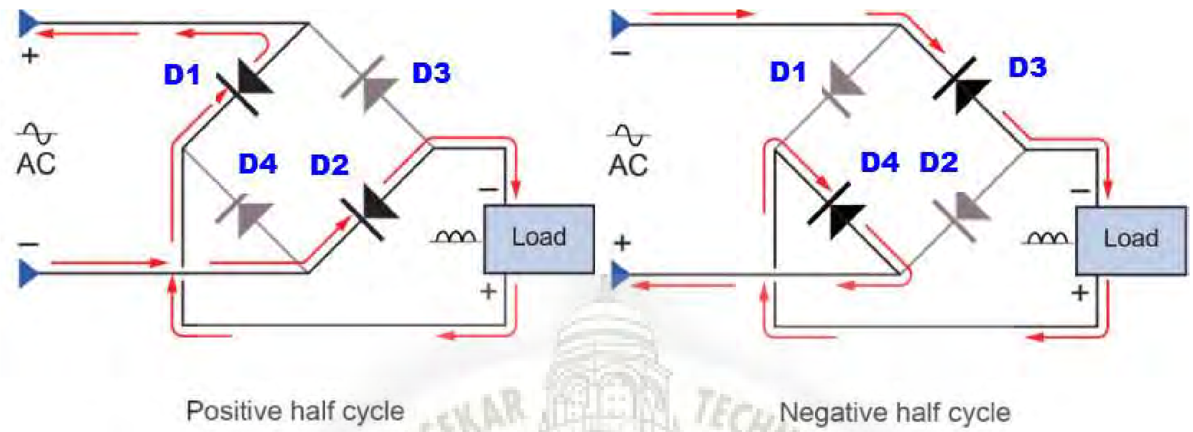


Fig. 3. Current path of +ve & -ve half cycle

Next if the negative pulse appears at the AC input, then the terminals A and B are negative and positive respectively. This forward biases the diodes D_2 and D_4, while reverse biasing D_1 and D_3 which causes the current to flow in the direction shown by Figure 2b. At this instant, one has to note that the polarity of the voltage developed across R_L is identical to that produced when the incoming AC pulse was positive in nature. This means that for both positive and negative pulse, the output of the bridge rectifier will be identical in polarity as shown by the wave forms in Figure.

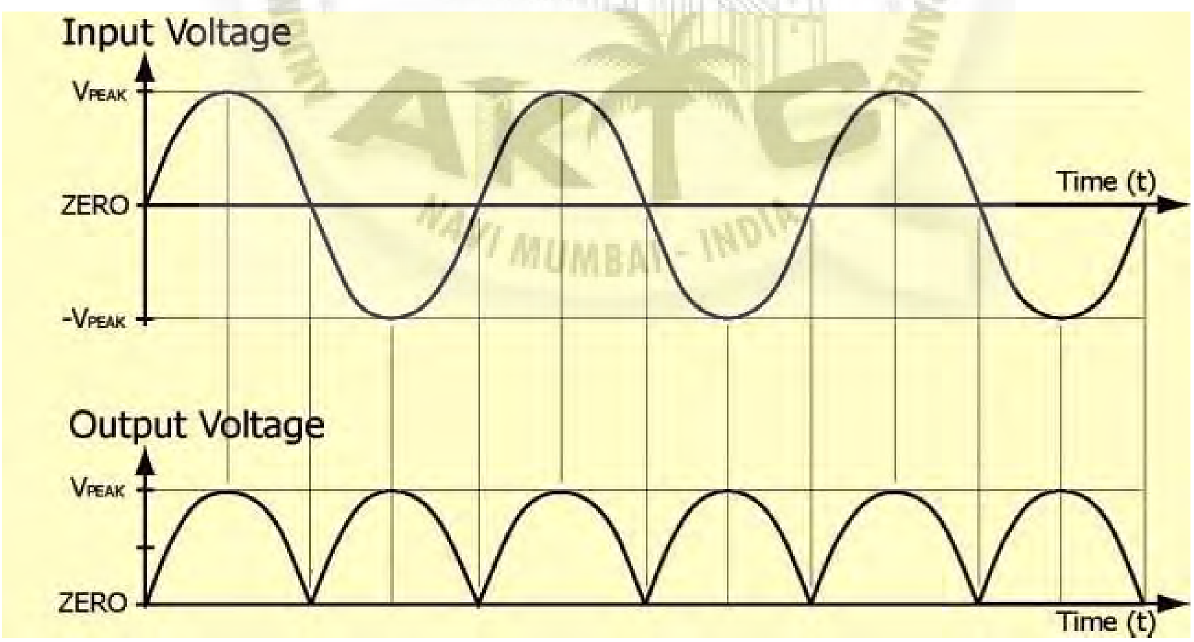


Fig. 4. Input & Outut waveform of bridge rectifier

However it is to be noted that the bridge rectifier's DC will be pulsating in nature. In order to obtain pure form of DC, one has to use capacitor in conjunction with the bridge circuit.

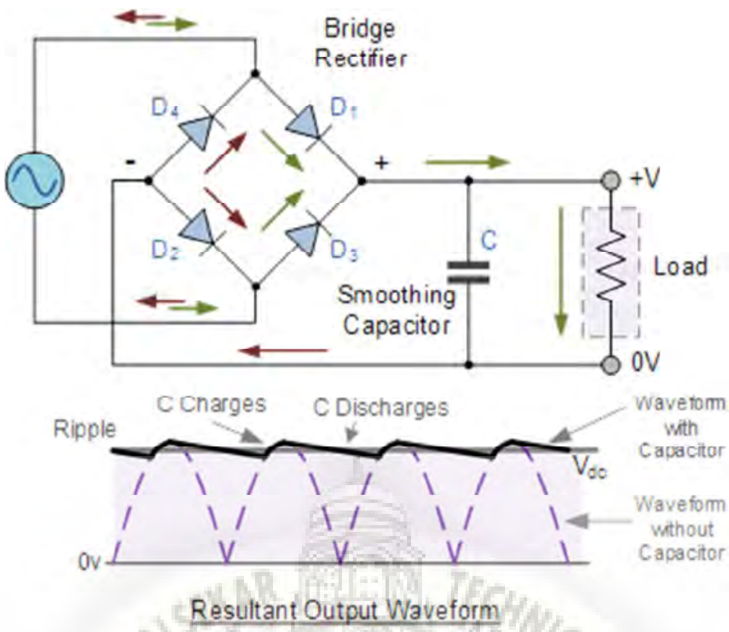


Fig. 5. Bridge rectifier with RC filter

In this design, the positive pulse at the input causes the capacitor to charge through the diodes D_1 and D_3. However as the negative pulse arrives at the input, the charging action of the capacitor ceases and it starts to discharge via R_L. This results in the generation of DC output which will have ripples in it as shown in the figure. This ripple factor is defined as the ratio of AC component to the DC component in the output voltage. In addition, the mathematical expression for the ripple voltage is given by the equation

$$V_r = \frac{I_l}{fC}$$

Where,
V_r represents the ripple voltage.
I_l represents the load current.
f represents the frequency of the ripple which will be twice the input frequency.
C is the Capacitance.

Further, the bridge rectifiers can be majorly of two types, viz., Single-Phase Rectifiers and Three-Phase Rectifiers. In addition, each of these can be either Uncontrolled or Half-Controlled or Full-Controlled. **Bridge rectifiers** for a particular application are selected by considering the load current requirements. These bridge rectifiers are quite advantageous as they can be constructed with or without a transformer and are suitable for high voltage applications. However here two diodes will be conducting for every half-cycle and thus the voltage drop across the diodes will be higher. Lastly one has to note that apart from converting AC to DC, bridge rectifiers are also used to detect the amplitude of modulated radio signals and to supply polarized voltage for welding applications.

2.4 Buck-Boost Converter

DC-DC converters are also known as Choppers. Here we will have a look at **Buck Boost converter** which can operate as a DC-DC Step-Down converter or a DC-DC Step-Up converter depending upon the duty cycle, D.

A typical Buck-Boost converter is shown below.

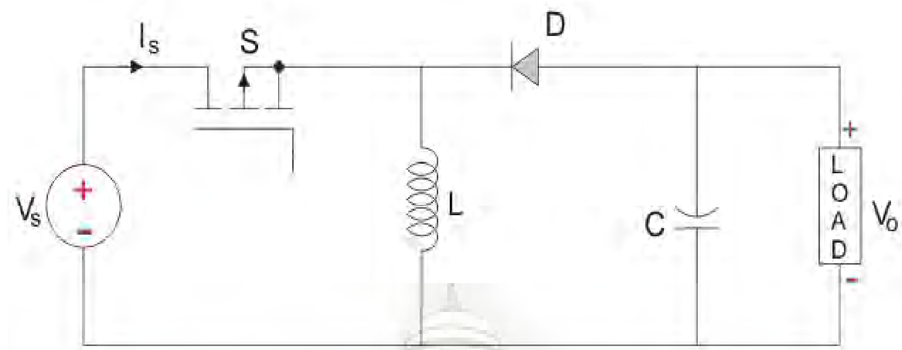


Fig. 6. Buck-Boost Converter

The input voltage source is connected to a solid state device. The second switch used is a diode. The diode is connected, in reverse to the direction of power flow from source, to a capacitor and the load and the two are connected in parallel as shown in the figure above.
The controlled switch is turned on and off by using Pulse Width Modulation (PWM). PWM can be time based or frequency based. Frequency based modulation has disadvantages like a wide range of frequencies to achieve the desired control of the switch which in turn will give the desired output voltage. Time based Modulation is mostly used for DC-DC converters. It is simple to construct and use. The frequency remains constant in this type of PWM modulation.

The **Buck Boost converter** has two modes of operation. The first mode is when the switch is on and conducting.

Mode I: Switch is ON, Diode is OFF

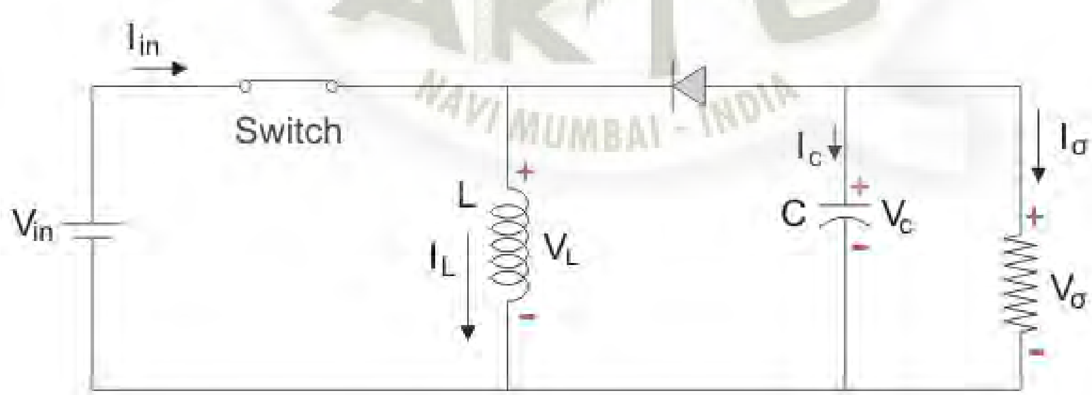


Fig. 7. Mode 1

The Switch is ON and therefore represents a short circuit ideally offering zero resistance to the flow of current so when the switch is ON all the current will flow through the switch and the inductor and back to the DC input source. The inductor stores charge during the time the switch is ON and when the solid state switch is OFF the polarity of the Inductor reverses so that current flows through the load and through the diode and back to the inductor. So the direction of current through the inductor remains the same.

Let us say the switch is on for a time T_{ON} and is off for a time T_{OFF}. We define the time period, T, as $T = T_{ON} + T_{OFF}$ and the switching frequency

$$f_{switching} = \frac{1}{T},$$

Let us now define another term, the duty cycle,

$$D = \frac{T_{ON}}{T}$$

Let us analyse the **Buck Boost converter** in steady state operation for this mode using KVL.

$$\therefore V_{in} = V_L$$

$$\therefore V_L = L\frac{di_L}{dt} = V_{in}$$

$$\frac{di_L}{dt} = \frac{\Delta i_L}{\Delta t} = \frac{\Delta i_L}{DT} = \frac{V_{in}}{L}$$

Since the switch is closed for a time T_{ON} = DT we can say that Δt = DT.

$$(\Delta i_L)_{closed} = \left(\frac{V_{in}}{L}\right) DT$$

While performing the analysis of the Buck-Boost converter we have to keep in mind that

1. The inductor current is continuous and this is made possible by selecting an appropriate value of L.
2. The inductor current in steady state rises from a value with a positive slope to a maximum value during the ON state and then drops back down to the initial value with a negative slope. Therefore the net change of the inductor current over any one complete cycle is zero.

Mode II: Switch is OFF, Diode is ON

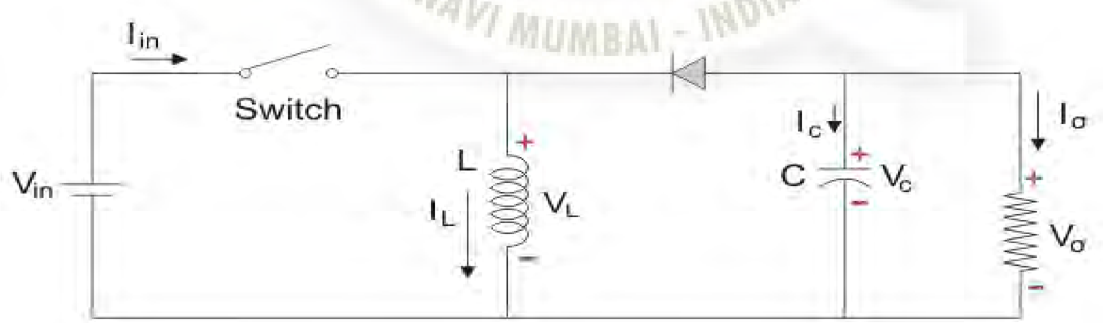


Fig. 8. Mode II

In this mode the polarity of the inductor is reversed and the energy stored in the inductor is released and is ultimately dissipated in the load resistance and this helps to maintain the flow of current in the same direction through the load and also step-up the output voltage as the inductor is now also acting

as a source in conjunction with the input source. But for analysis we keep the original conventions to analyse the circuit using KVL.
Let us now analyse the **Buck Boost converter** in steady state operation for Mode II using KVL.

$$\therefore V_L = V_o$$
$$\therefore V_L = L\frac{di_L}{dt} = V_o$$
$$\frac{di_L}{dt} = \frac{\Delta i_L}{\Delta t} = \frac{\Delta i_L}{(1-D)T} = \frac{V_o}{L}$$

Since the switch is open for a time $T_{OFF} = T - T_{ON} = T - DT = (1-D)T$ we can say that $\Delta t = (1-D)T$.

$$(\Delta i_L)_{open} = \left(\frac{V_o}{L}\right)(1-D)T$$

It is already established that the net change of the inductor current over any one complete cycle is zero

$$\therefore (\Delta i_L)_{closed} + (\Delta i_L)_{open} = 0$$
$$\left(\frac{V_o}{L}\right)(1-D)T + \left(\frac{V_{in}}{L}\right)DT = 0$$
$$\frac{V_o}{V_{in}} = \frac{-D}{1-D}$$

We know that D varies between 0 and 1. If D > 0.5, the output voltage is larger than the input; and if D voltage.

2.5 Capacitor

There are three fundamental electronic components that form the foundation of a circuit – resistors, inductors, and **capacitors**. A **capacitor** in an electrical circuit behaves as a charge storage device. It holds the electric charge when we apply a voltage across it, and it gives up the stored charge to the circuit as when required. The most basic construction of a capacitor consists of two parallel conductors (usually metallic plates) separated by a dielectric material. When we connect a voltage source across the capacitor, the conductor (capacitor plate) attached to the positive terminal of the source becomes positively charged, and the conductor (capacitor plate) connected to the negative terminal of the source becomes negatively charged. Because of the presence of dielectric in between the conductors, ideally, no charge can migrate from one plate to other.

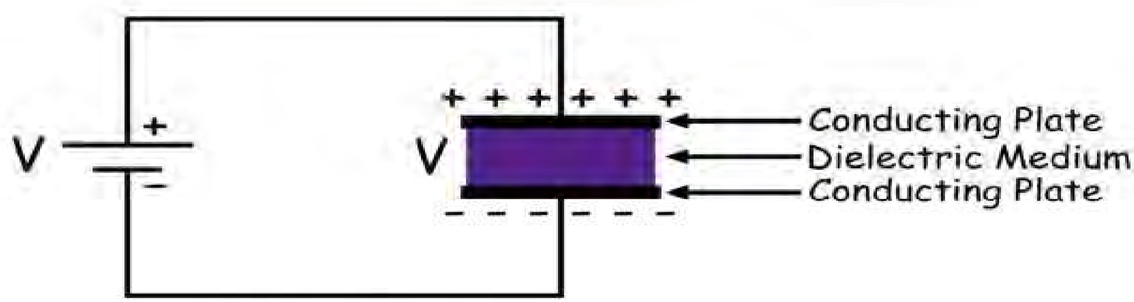


Fig. 9. Capacitor

So, there will be a difference in charging level between these two conductors (plates). Therefore an electric potential difference appears across the plates. The charge accumulation in the capacitor plates is not instantaneous rather it is gradually changing. The voltage appears across the capacitor exponentially rises until it becomes equal to that of the connected voltage source.

2.6 Laed Acid Battery

Lead–acid batteries, invented in 1859 by French physicist Gaston Planté, are the oldest type of rechargeable battery. Despite having a very low energy-to-weight ratio and a low energy-to-volume ratio, their ability to supply high surge currents means that the cells maintain a relatively large power-to-weight ratio. These features, along with their low cost, make them attractive for use in motor vehicles to provide the high current required by automobile starter motors.

Fig. 10. Lead Acid Battery

2.6.1 History

In 1859, Gaston Planté's lead-acid battery was the first battery that could be recharged by passing a reverse current through it. Planté's first model consisted of two lead sheets separated by rubber strips and rolled into a spiral.[2] His batteries were first used to power the lights in train carriages while stopped at a station. In 1881, Camille Alphonse Faure invented an improved version that consisted of a lead grid lattice into which a lead oxide paste was pressed, forming a plate. This design was easier to mass-produce.

The lead-acid battery is still used today in automobiles and other applications in which greater weight is acceptable. In the 1970s the valve-regulated lead acid battery (often called "sealed") was developed; it used a gel electrolyte instead of a liquid, allowing the battery to be used in different positions without leakage.

2.6.2 Discharge

Fully Discharged: Two identical lead sulphate plates

In the discharged state both the positive and negative plates become lead (II) sulphate ($PbSO_4$) and the electrolyte loses much of its dissolved sulphuric acid and becomes primarily water. The discharge process is driven by the conduction of electrons from the negative plate back into the cell at the positive plate in the external circuit.

Negative plate reaction (Anode Reaction):

$Pb(s) + HSO^{-}_4(aq) \rightarrow PbSO_4(s) + H^+(aq) + 2e^-$

Positive plate reaction (Cathode Reaction):

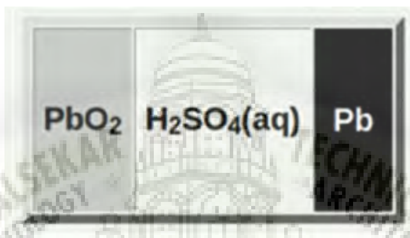
$PbO_2(s) + HSO^{-}_4(aq) + 3H^+(aq) + 2e^- \rightarrow PbSO_4(s) + 2H_2O(l)$

The total reaction can be written:

$Pb(s) + PbO_2(s) + 2H_2SO_4(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$

The sum of the molecular weights of the reactants is 642.6, so theoretically a cell can produce two faradays of charge from 642.6 g of reactants, or 83.4 amp-hours per kg (or 13.9 amp-hours per kg for a 12-volt battery). At 2 volts per cell, this comes to 167 watt-hours per kg, but lead-acid batteries in fact give only 30 to 40 watt-hours per kg due to the weight of the water and other factors.

2.6.3 Charge



Fully Charged: Lead and Lead Oxide plates

In the charged state, each cell contains negative plates of elemental lead (Pb) and positive plates of lead (IV) oxide (PbO_2) in an electrolyte of approximately 33.5% *v*/*v* (4.2 Molar) sulfuric (H_2SO_4). The charging process is driven by the forcible removal of electrons from the positive plate and the forcible introduction of them to the negative plate by the charging source.

Negative plate reaction:

$PbSO_4(s) + H^+(aq) + 2e^- \rightarrow Pb(s) + HSO^{-}_4(aq)$

Positive plate reaction:

$PbSO_4(s) + 2H_2O(l) \rightarrow PbO_2(s) + HSO^{-}_4(aq) + 3H^+(aq) + 2e^-$

2.7 CD4047

It is a CMOS Low Power monostable/astable multivibrator mainly used for converting DC current signal to AC signal. This inverter proves to be very handy in some countries where load-shedding creates a significant problem as it comes with an ability to store electrical energy and discharge it in the absence of main electrical power.

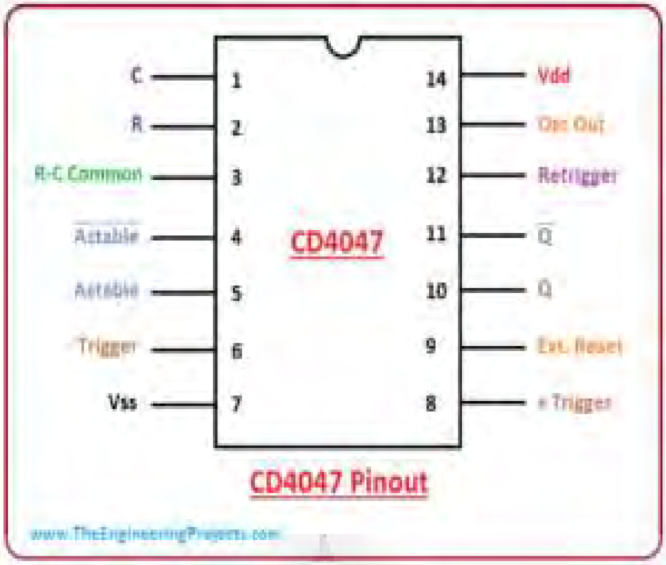


Fig. 11. CD4047

There are 14 pins available on the IC where Vss is a ground pin and Vdd is a voltage supply pin. There are six inputs including trigger', trigger, astable, astable', external reset and retrigger. While buffer outputs include three outputs mentioned as Q, Q', and Oscillator. Both astable and astable' take part for triggering the operation by keeping high level on the former and low level on the later.

The IC behaves as a gatable multivibrator if complement pulses on the astable' and true pulses are applied on the astable pins. The CD4047 will be only triggering in a monostable state when a positive edge appears on the +trigger with trigger keeping low.

2.7.1 Introduction to CD4047

CD4047 is a CMOS Low Power monostable/astable multivibrator mainly used for converting DC current signal to AC signal. It comes with a high voltage rating around 20-V.

CD4047 is a 14 pin IC that operates on a logic techniques with an ability to allow negative or positive edge-triggered monostable multivibrator action layered with retriggering and external counting options.

Accurate and complemented buffered output with low power consumption make this IC an ideal choice for Frequency Division and Time Delay applications.

Fig. 12. CMOS low power multivibrator.

The internal power-on reset circuit is added on the IC and fast recovery time makes it an independent from the pulse width.
There is a sheer difference involved when IC works in monostable and astable mode. In monostable mode, the inverter needs a trigger signal for generating the output pulse, but an astable multivibrator doesn't require trigger signal for every output pulse. More often than not, an astable multivibrator can be called as an oscillator.

2.7.2 Working in Monostable Mode

In Monostable Mode, an external resistor must be connected between Pin 1 & 3 of the IC that helps in determining the output pulse width. We will be using +trigger and –trigger Pin in this mode.

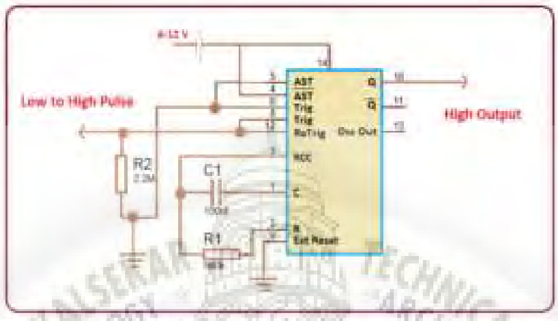


Fig. 13. Working in monostable mode

Both pins will generate the Monostable output when we provide High to Low transition at –trigger Pin and Low to High transition at +trigger Pin.
The following formula is used to determine the frequency at Pin 10 & 11

f = 1 / 8.8 x R*C

2.7.3 Working in Astable Mode

As mentioned earlier in astable mode, the inverter needs a trigger signal for generating the output pulse. The output frequency is determined when a single capacitor is connected between PIN 2 and 3.

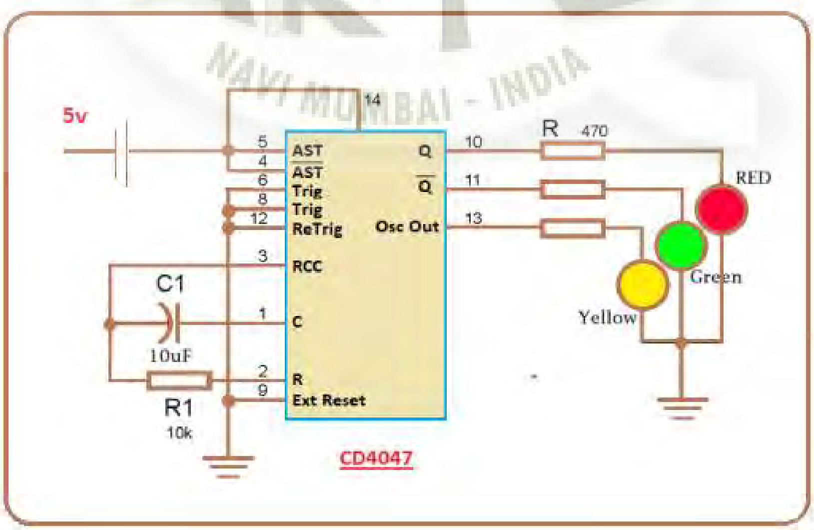


Fig. 14. Working in astable mode

The IC will be operating is an Astable mode when we apply HIGH on Pin 5 and LOW on Pin 4, generating the output toggling between HIGH and LOW.
The oscillated output frequency on Pin 13 can be determined using the following formula

$$\mathbf{F} = 1 / 4.4 \times R*C$$

Similarly, the formula to find the time it takes to generate pulse will be given as:

$$\mathbf{t} = 2.48 \times R*C$$

2.7.4 Application

This inverter comes with a wide range of applications that are mainly related to DC to AC conversion. Following are the main applications it can be used for.

- Frequency division
- Frequency multiplication
- Timing delay applications
- Timing circuits
- Frequency discriminators

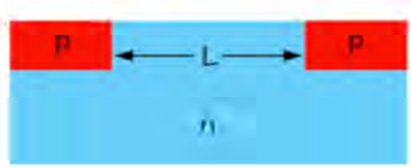
2.8 MOSFET

MOSFET stands for Metal Oxide Semiconductor Field Effect Transistor. The mosfet is a capacitor operated transistor device. The capacitor plays an essential role for operating a MOSFET. We also call the device as Insulated Gate Field Effect Transistor (IGFET) or Metal Insulator Field Effect Transistor (MIFET). Why we call so we will understand when we look into the constructional features of this transistor device. We must take a look into the construction of MOSFET while going through the working principle of mosfet. Construction wise we can categorise the device into four types.

- P – Channel Enhancement MOSFET
- N – Channel Enhancement MOSFET
- P – Channel Depletion MOSFET
- N – Channel Depletion MOSFET

2.8.1 P – Channel Enhancement MOSFET

We also call the **p channel MOSFET** as **PMOS**. Here, a substrate of lightly doped n-type semiconductor forms the main body of the device. We usually use silicon or gallium arsenide semiconductor material for this purpose. Two heavily doped p-type regions are there in the body separated by a certain distance L. We refer this distance L as **channel length** and it is in order of 1 µm.



Now there is a thin layer of silicon dioxide (SiO_2) on the top of the substrate. We may also use Al_2O_3 for the purpose but SiO_2 is most common. This layer on the substrate behaves as a dielectric. There is an aluminium plate fitted on the top of this SiO_2 dielectric layer.

Now the aluminium plate, dielectric and semiconductor substrate form a capacitor on the device.
The terminals connected to two p-type regions are the source (S) and drain (D) of the device respectively. The terminal projected from the aluminium plate of the capacitor is gate (G) of the device. We also connect the source and body of the mosfet to earth to facilitate the supply and withdrawal of free electrons as per requirement during operation of the MOSFET.

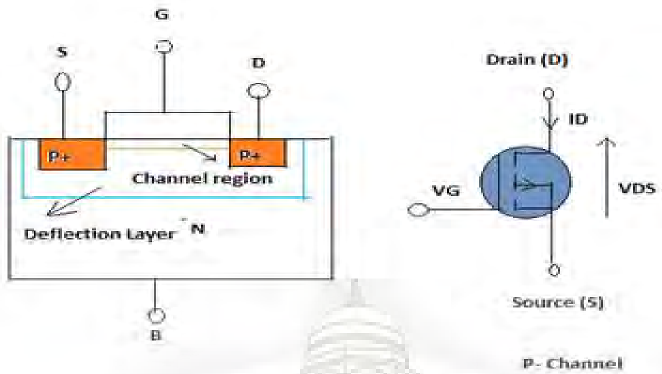


Fig. 15. P- Channel MOSFET

Now let us apply a negative voltage at gate (G). This will create negative static potential at the aluminium plate of the capacitor. Due to capacitive action, positive charge gets accumulated just below the dielectric layer.

Basically, the free electrons of that portion of the n-type substrate get shifted away due to the repulsion of negative gate plate and consequently layers of uncovered positive ions appear here. Now if we further increase the negative voltage at the gate terminal, after a certain voltage called threshold voltage, due to the electrostatic force, covalent bonds of the crystal just below the SiO_2 layer start breaking. Consequently, electron-hole pairs get generated there. The holes get attracted and free electrons get repealed due to the negativity of the gate. In this way, the concentration of holes increases there and create a channel of holes from source to drain region. Holes also come from both heavily doped p-type source and drain region. Due to the concentration of holes in that channel the channel becomes conductive in nature through which electric current can pass.

2.8.2 N – Channel Enhancement MOSFET

Working of N – Channel Enhancement MOSFET is similar to that of P – Channel Enhancement MOSFET but only operationally and constructionally these two are different from each other. In N Channel Enhancement MOSFET a lightly doped p-type substrate forms the body of the device and source and drain regions are heavily doped with n-type impurities. Here also we connect the body and source commonly to the ground potential. Now, we apply a positive voltage to the gate terminal. Due to positivity of the gate and corresponding capacitive effect, free electrons i.e. minority carriers of the p-type substrate get attracted towards the gate and form a layer of negative uncovered ions there just below the dielectric layer by recombining these free electrons with holes. If we continually increase the positive gate voltage, after the threshold voltage level, the recombinations process gets saturated and then free electrons start to accumulate at the place to form a conductive channel of free electrons. The free electrons also come from the heavily doped source and drain n-type region. Now if we apply a positive voltage at the drain, current start flowing through the channel. The resistance of the channel depends on the number of free electrons in the channel and the number of free electrons in the channel again depends on the gate potential of the device. As the concentration of free electrons forms the channel, and the current through the channel gets enhanced due to increase in gate voltage, we name the MOSFET as N – Channel Enhancement MOSFET.

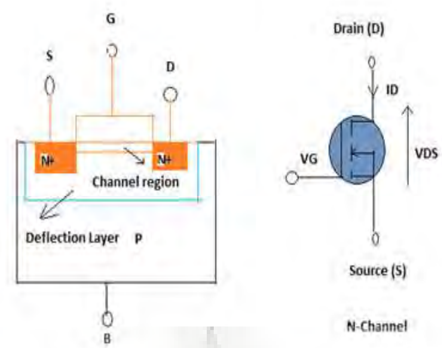


Fig. 16. N-Channel MOSFET

Chapter 3

3.1 Transformer

A transformer is a static machine used for transforming power from one circuit to another without changing frequency. This is a very basic ***definition of transformer***. Since, there is no rotating or moving part, so a transformer is a static device. Transformer operates on an AC supply. A transformer works on the principle of mutual induction.

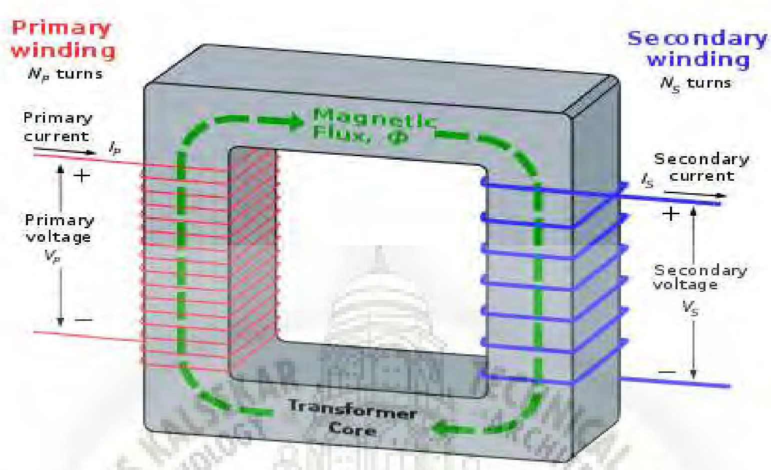


Fig. 17. Transformer

3.2 Working Principle of Transformer

It works on the principle of mutual induction of two coils or Faraday Law's Of Electromagnetic induction. When current in the primary coil is changed the flux linked to the secondary coil also changes. Hence an EMF is induced in the secondary coil due to Faraday law's of electromagnetic induction.

The transformer is based on two principles: first, that an electric current can produce a magnetic field (electromagnetism) and second that a changing magnetic field within a coil of wire induces a voltage across the ends of the coil. Changing the current in the primary coil changes the magnetic flux that is developed. The changing magnetic flux induces a voltage in the secondary coil.

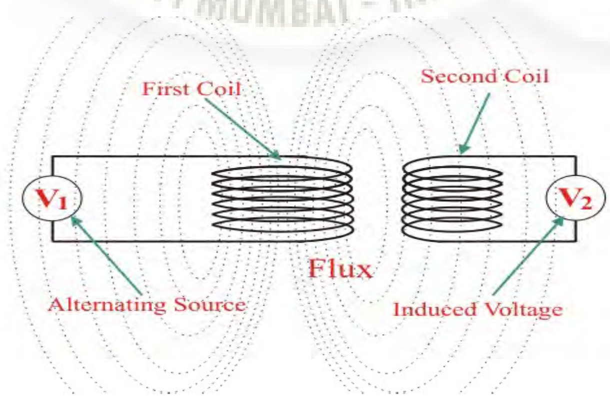


Fig. 18. Working of transformer

3.3 Step-Up Transformer

A transformer is static electrical equipment which transforms electrical energy (from primary side windings) to the magnetic energy (in transformer magnetic core) and again to the electrical energy (on the secondary transformer side). The operating frequency and nominal power are approximately equal on primary and secondary transformer side because the transformer is a very efficient piece of equipment – while the voltage and current values are usually different. Essentially, that is the main task of the transformer, converting high voltage (HV) and low current from the primary side to the low voltage (LV) and high current on the secondary side and vice versa. Also, a transformer with its operation principle provides galvanic isolation in the electrical system. With those features, the transformer is the most important part of the electrical system and provides economical and reliable transmission and distribution of electrical energy.

The transformer can transfer energy in both directions, from HV to LV side as well as inversely. That is the reason why it can work as a voltage step-up or step-down transformer. Both transformer types have the same design and construction. Theoretically, we can operate any transformer as step-up as well as step-down type. It only depends on the energy flowing direction.

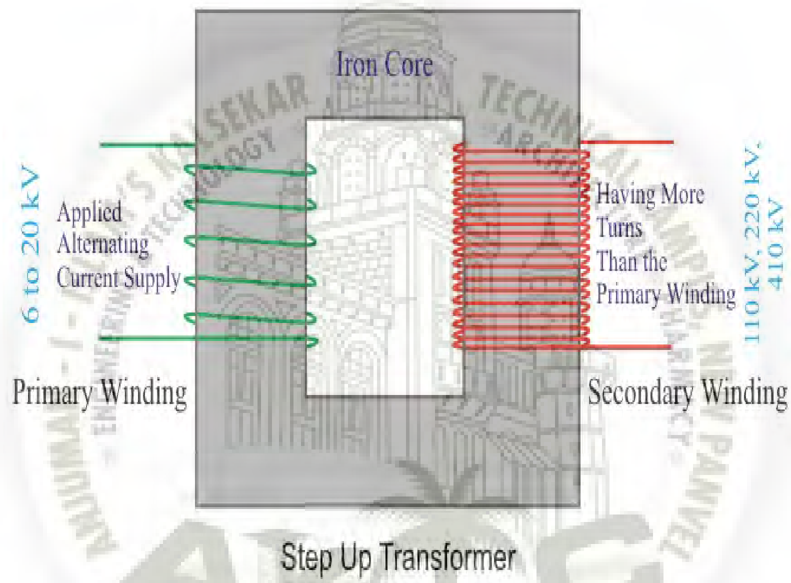


Fig. 19. Step-Up Transformer

The HV windings contain a huge number of turns compared with the LV windings. An LV winding wire has bigger cross-section than HV wire because of higher current value on the LV side. Usually, we place the LV windings close to the transformer core, and over them, we wound the HV windings.
Transformer turns ratio is approximately proportional to the voltage ratio:

$$\frac{U_1}{U_2} = \frac{N_2}{N_2}$$

Where $U_{1,2}$ are voltages and $N_{1,2}$ are the turns numbers on HV and LV side). The primary side of a **step-up transformer** has a small number of turns (LV side) while secondary side has a large number of turns (HV side). That means energy flows from the LV to HV side. The most important application of step-up transformer is a generator step-up (GSU) transformer used in all generating plants. Those transformers usually have large turn's ratio value. The voltage value produced in energy generation is increased and prepared to the long distance energy transmission. The energy produced in generating plant is at low voltage and high current values. Depending on the generating plant type, the GSU transformer has nominal primary voltage value from 6 up to 20 kV.

3.3.1 Step-Up Transformer Applications

A small **step-up transformers** can be used in electronic and electrical devices where the voltage boosting is required. But nowadays in the modern electronic device, power electronic circuits are more frequently used because of weight and dimension. As we told already, giant power step-up transformer is used as generating step-up transformer for stepping up the generated power to a higher voltage level for efficient transmission purposes.

3.4 Step-Down Transformer

A step-down transformer converts the high voltage (HV) and low current from the primary side to the low voltage (LV) and high current value on the secondary side. This transformer type has a wide application in electronic devices and electrical systems. When it comes to the operation voltage, the step-up transformer application can be roughly divided in two groups: LV (voltages up to 1 kV) and HV application (voltages above 1 kV).
The first LV application refers to the transformers in electronic devices. Supplying the electronic circuits requires a low voltage value (e.g. 5V, even lower values nowadays). A **step down transformer** is used to provide this low voltage value which is suitable for electronics supplying. It transforms home voltage (230/120 V) from primary to a low voltage on the secondary side which is used for the electronic supplying. If electronic devices are designed to have higher nominal power, transformers with high operating frequency are used (kHz-s). The transformers with higher nominal power value and 50/60 Hz nominal frequency would be too large and heavy. Also, the daily used battery chargers use the step-down transformer in its design.

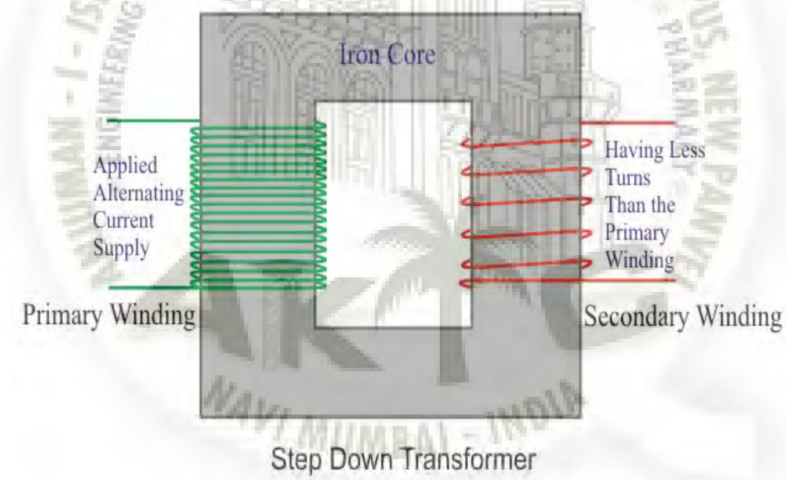


Fig. 20. Step-down Transformer

The step-down transformers have a very important function in power system. They lower the voltage level and adapt it for energy consumers. It is performed in several steps described below:
A long distance energy transmission system should have voltage level as high as possible. With high voltage and low current, the transmission power loss $R \times I^2$ will be significantly decreased. A power grid is designed that has to be connected with the transmission system with the different voltage levels. Step-down transformers are used in interconnection of transmission systems with different voltage level. They decrease voltage level from high to lower value (e.g. 765/220 kV, 410/220 kV, 220/ 110 kV). These transformers are huge and have very high nominal power (even 1000 MVA). In this case, when the transformer turns ratio is not high the auto transformers are usually installed.

The next voltage level transformation step is adapting transmission voltage to the distribution level. The characteristic voltage ratios in this case are 220/20 kV, 110/20 kV (also the LV secondary voltages 35 kV and 10 kV can be found). The nominal power of those transformers is up to 60 MVA (usually 20 MVA). The on-load tap changer is almost always installed in these transformers. A voltage regulation is the main function of tap changer. In USA the tap changer is based on LV side, and in rest of the world mostly on the HV transformer side.

The final voltage transformation step is adapting the voltage to the home voltage level $(\sqrt{3}\ 230\ V\ or\ \sqrt{3}\ 120\ V)$

These transformers are known as small distribution transformers with nominal power up to 5 MVA (mostly below of 1 MVA) and with nominal voltage values 35, 20, 10 kV on HV side and 400/200 V on LV side. It is noticeable that those transformers have high turn's ratio. They usually have de-energized tap changer with 5 tap position (+/- 2 tap position) and do not have on load tap changer.

Chapter 4

4.1 Circuit Diagram

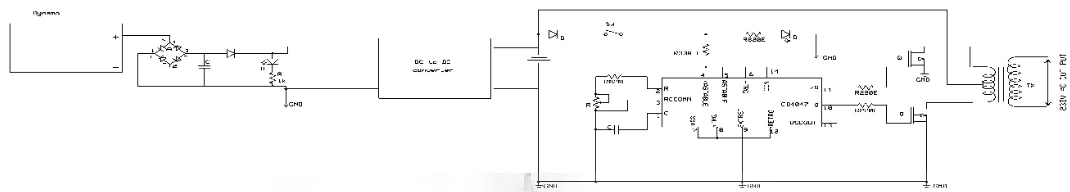


Fig. 21. Circuit Diagram

4.2 Working of circuit

As we see the circuit diagram is shown above we are generating electric power through gym equipment (abs workout machine).In the circuit the first part is dynamo which is connected to the gym equipment through pinion. The movement of the gym equipment is linear that is forward and backward but the dynamo has the rotary motion so we connect the equipment with dynamo with the use of pinion. As the exercise starts the linear motion of forward and backward starts and due to this the teeth rotates and the rotary motion is generated and we get the electric power. The dynamo rotates in both the direction and thus when it rotates in clockwise we get +ve & -ve power and in anticlockwise we get -ve & +ve DC supply. The rating of the dynamo is 6volts, 3watts, 100 rpm. After the dynamo the second part in the circuit is a bridge of 4 diodes. The output of the dynamo is given to the bridge because of which the output of dynamo +ve & -ve or -ve & +ve at the end of bridge we get +ve & -ve DC output. The diode used in the bridge is 1N4007, 1 amp rating. The next part in the circuit is filter capacitor that is used to filter the pulses generated in the output. The filter capacitor rating is 1000mircofarad.To see whether the power is being generated or not a led is fixed after the filter that glows when the power is generated. After that a diode 1N4007 is connected in the circuit and through this the power is stored in the battery. The main function of this diode is that is the power is not generating then the power from the battery should not flow in reverse direction. The battery rating is 6 Volts, 4.5 amp which is a rechargeable battery .The power generated is stored in this battery up to this the circuit is called as charging circuit.

The power generated is 6volt DC but we want 230v AC supply so we convert the DC power into Ac using power inverter and then stepping up the voltage to 230 volts using a centre tapped step up transformer. The primary rating of transformer is 6volt and the secondary rating is 230 volts. To convert the DC supply into Ac a MOSFET is connected in series from source to drain as a switching Device. Now the gate terminal of the two MOSFET is fired alternatively. If we fire the above MOSFET then the supply will flow from the battery to transformer to MOSFET then reach at the negative terminal of the battery and in the output we get a positive pulse 230 volts. Now if we fire the other MOSFET the supply flow from battery to transformer to MOSFET and reaches to the negative terminal of battery and we get negative pulse 230volts in the output. The same rating battery is connected in this circuit and the positive of this battery is connected to the transformer and if we give the negative of the battery to the transformer then it will not give 230v AC output. Therefore we use MOSFET to convert the DC to AC.

Thus the alternatively firing of the MOSFET is repeated and we get 230v AC output. The MOSFET here is being ON and OFF at 50 Hz to achieve the 230v AC output as 50Hz.For this we use digital oscillator IC CD4047. The Vcc pin is given to the supply through ON and OFF switch and the ground pin makes the ground common. In the R and C pin the resistor and the capacitor is connected that will decide the oscillation frequency.one resistor will be variable to match with the fluctuating frequency. The output of this IC is Q and Q bar that is complementary. The one output is given to one MOSFET through current limiting resistor similarly the other is given to the other MOSFET. The MOSFET here used is n-channel because it will be Off in zero and will be ON in 1 .The MOSFET here used is IRFZ44, 15 amp current rating. Here the p-channel MOSFET is not used because it gets ON in zero that means if the oscillator is OFF then also the power will flow and short circuit occur therefore we use N-channel MOSFET. The load used in the circuit is 6Watts CFL bulb.

Now if the battery is fully chat then for how many hours the load will be ON is called as backup time. To calculate this see the load in the output, here the output is 6Watts CFL bulb. Therefore the load at primary will be the load which is at secondary or 6Watts (neglecting losses). And in primary the voltage level is 6volts.

$$P=VI$$

$$6w/6volts=1amp$$

Therefore the discharge current will be 1 amp and the battery rating is 4.5 amp so,

4.5 amphr/ 1 Amp = 4.5 hrs. which is the backup time

That is the load will be ON for 4.5 hrs. if the battery is fully charged

Now charging time that is how much time is required to charge the battery. For charging time the total power produced is 3watts and the voltage rating is 6volts therefore the charging current is given as.

$$3watts/6volts = 0.5 ampere$$

And the battery rating is 4.5 amp so the charging time will be

4.5 amphr/0.5 amp= 9 hrs.

Chapter 5

5.1 Fabrication of PCB

P.C.B. is printed circuit board which is of insulating base with layer of thin copper-foil. The circuit diagram is then drawn on the P. C. B. with permanent marker and then it is dipped in the solution of ferric chloride so that unwanted copper is removed from the P.C.B., thus leaving components interconnection on the board. The specification of the base material is not important to know in most of the application, but it is important to know something about copper foil which is drawn through a thin slip. The resistance of copper foil will have an affect on the circuit operation.

Base material is made of lamination layer of suitable insulating material such as treated paper, fabric; or glass fibres and binding them with resin. Most commonly used base materials are formed paper bonded with epoxy resin. It is possible to obtain a range of thickness between 0.5 mm to 3 mm. Thickness is the important factor in determining mechanical strength particularly when the commonly used base material is "**Formea**" from paper assembly.

Physical properties should be self-supporting these are surface resistivity, heat dissipation, dielectric, constant, dielectric strength. Another important factor is the ability to withstand high temperature.

5.2 Designing the Layout

While designing a layout, it must be noted that size of the board should be as small as possible. Before starting, all components should be placed properly so that an accurate measurement of space can be made. The component should not be mounted very close to each other or far away from one another and neither one should ignore the fact that some component reed ventilation, which considerably the dimension of the relay and transformer in view of arrangement, the bolting arrangement is also considered. The layout is first drawn on paper then traced on copper plate which is finalized with the pen or permanent marker which is efficient and clean with etching.

The most difficult part of making an original printed circuit is the conversion from, theoretical circuit diagram into wiring layout. Without introducing cross over and undesirable effect. Although it is difficult operation, it provides greatest amount of satisfaction because it is carried out with more care and skill. The board used for project has copper foil thickness in the range of 25 40 75 microns. The soldering quality requires 99.99% efficiency. It is necessary to design copper path extra-large. There are two main reasons for this. The copper may be required to carry an extra-large overall current is It acts like a kind of screen or ground plane to minimize the effect of interaction. The first function is to connect the components together in their right sequence with minimum need for interlinking i.e. the jumpers with wire connections.

After that holes are drilled with 1 mm or 0.8 mm drill. Now the marker on the P. C. B. is removed. The Printed Circuit Board is now ready for mounting the components on it.

5.3 Soldering

For soldering of any joints first the terminal to be soldered are cleaned to remove oxide film or dirt on it. If required flux is applied on the points to be soldered. Now the joint to be soldered is heated with the help of soldering iron. Heat applied should be such that when solder wire is touched to joint, it must melt quickly. The joint and the soldering iron is held such that molten solder should flow smoothly over the joint. When joint is completely covered with molten solder, the soldering iron is removed. The joint is allowed to cool, without any movement. The bright shining solder indicates good soldering. In case of dry solder joint, an air gap remains in between the solder maternal and the joint. It means that soldering is improper. This is removed and again soldering is done. Thus this way all the components are soldered on P. C. B.

Chapter 6

6.1 Testing & Troubleshooting

Before you apply power, read the instructions carefully to check you haven't missed anything, and whether there are any specific instructions for switching on and testing. Check again that you have all polarity sensitive components the right way around, and that all components are in the correct places. Check off - board components are connected correctly. Check the underside of the board carefully for short circuits between tracks - a common reason for circuits failing to work.

When you are sure everything is correct, apply power and see if the circuit behaves as expected, again following the kit manufacturer's instructions.

If it works, WELL DONE! You have your first working circuit - be proud of it! Skip the rest of this page and click the right arrow at the bottom, or here.

If it doesn't quite work as expected, or doesn't work at all, don't despair. The chances are the fault is quite simple. However, disconnect the power before reading on.

Check the basic's first - is the battery flat? Are you sure the 'On' switch really is on? (Don't laugh, it's easily done) If the project has other switches and controls check these are set correctly.

Next - check again all the components are in the correct place - refer to the diagram in the instructions. Look again at the underside of the board - are there any short circuits? These can be caused by almost invisible 'whiskers' of solder, so check for these with a magnifying glass in good light. Brushing the bottom of the board vigorously with a stiff brush can sometimes remove these.

Pull the components gently to see if they are all fixed into the board properly. Check the soldered joints - poor soldering is the most common cause of circuits failing to work. The joints should by shiny, and those on the circuit board should be volcano shaped with the component wire end sticking out of the top. If any look suspect then redo them. Remove the solder with a solder sucker or braid and try again.

Check for solder splashes shorting across adjacent tracks on the circuit board, especially where connections are very close such as on integrated circuits ('chips'). Solder splashes are most likely on strip board. You can check for shorts using a multimetre set it to its continuity range, or low resistance range. Be aware if you do this though, that there will be a resistance between some tracks due to the components. Any resistance below 1 ohm between tracks is likely to be a solder splash. Run the soldering iron between tracks on strip board to remove any solder bridges.

If the circuit still fails to work you will need to refer to the circuit diagram and take voltage readings from the circuit to find out what's wrong. You will need a multimetre to do this (see tools). Remember that if you find one fault such as a reversed component and correct it, it might have caused damage to other components.

Beginners Guide - More Tools & Test Equipment. To design your own circuits, or build more complex kits, you will probably need more in the way of tools and test equipment. If you did not buy a multimeter before then this is essential now, a basic power supply is also very useful. More expensive items such as an oscilloscope can be useful, but think carefully about whether you really need them - after all, you can build a lot of projects for the price of an oscilloscope. PC-based virtual instruments could perhaps be more suitable. Other tools can be useful too. Here is a list of other useful items, although this by no means covers all the tools and equipment available. Maplin codes are included, however similar items are available from most suppliers.

6.2 Tools

6.2.1 Helping Hands

Useful for holding PCB's, connectors etc. while you solder them. Also normally have a magnifying glass to help see small components. Can save hours of aggravation! Maplin code YK53H A small vice can also be useful and provides a more rigid mounting than a Helping Hands.

6.2.2 Pearl Catcher

Useful for the retrieving those screws that inevitably fall into the most inaccessible corner of a project! Maplin code BK43W

6.2.3 Heat Shunt

An inexpensive item for soldering heat sensitive devices. Clipped onto the component lead between the joint and the component it will soak up the heat to save you melting your components. As you get faster at soldering you probably won't need it so much. Maplin code FR10L

6.2.4 RCD Circuit Breaker

If you start building mains projects (only do this when you are more experienced and are aware of the safety requirements) then one of these is ESSENTIAL. It could also prevent a shock if you accidentally melt through the soldering iron flex. These are sold very cheaply in most electrical shops. Well worth the price, although check if your building wiring is already protected by an RCD in the consumer unit first.

6.2.5 Breadboard

If you want to test a circuit without soldering it together permanently then these are useful. Just push the wires into holes joined by metal strips to build the circuit. If the circuit doesn't work, you can easily make changes. Different sizes are available, e.g. Maplin code AG10L

6.2.6 Other items

Other sizes of screwdriver, 0.5Kg reel of solder, tool roll or box etc.

6.3 Test Equipment:

6.3.1 Multimeter

Almost essential for all but the absolute beginner. See the tools section for more information.

6.3.2 Power Supply

Also very useful for powering circuits that you are testing. One with a variable voltage up to at least 12V is best. The current rating doesn't need to be that high, 1A maximum is fine for most jobs. If you can afford it then one with an adjustable current limit is useful - set right it can prevent damage to an incorrect circuit, rather than frying it instantly!

6.3.3 Oscilloscope

Quite expensive and not really worth it for all but the advanced constructor. Nonetheless a very useful piece of test equipment, especially on audio circuits. There are some cheaper PC based alternatives, and some hand - held 'scopes now, although I haven't tried them.

6.3.4 Signal Generator

Useful when testing audio circuits, again not really necessary for beginners. Produces variable frequency waves of several different waveforms (sine, square, triangle)

Chapter 7

7.1 Advantages

- No need of fuel input.
- This is a Non-conventional system.
- Battery is used to store the generated power.

7.2 Disadvantages

- Only applicable for the particular place.
- Mechanical moving parts are is more initial cost of this arrangement is high care should be taken for batteries.

7.3 Applications

- Power generation using gym ABS machine can be used most of places such as Colleges, Schools & Gym centre

Chapter 8

8.1 Future Scope

- The energy generation from gym equipment can be also enhanced as now a day most of the population are health conscious and they are spending time for exercise in gym or another suitable place. If energy generation is large in amount then it can be also used for commercial purpose also.
- In future, if the flywheel speed control device and voltage protection devices can be added with large generation process, it would be a model all over the world.

Conclusion

The project 'power generation through gym equipment' has been successfully designed and tested. It has been developed by integrating features of all the hardware components used. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit.

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