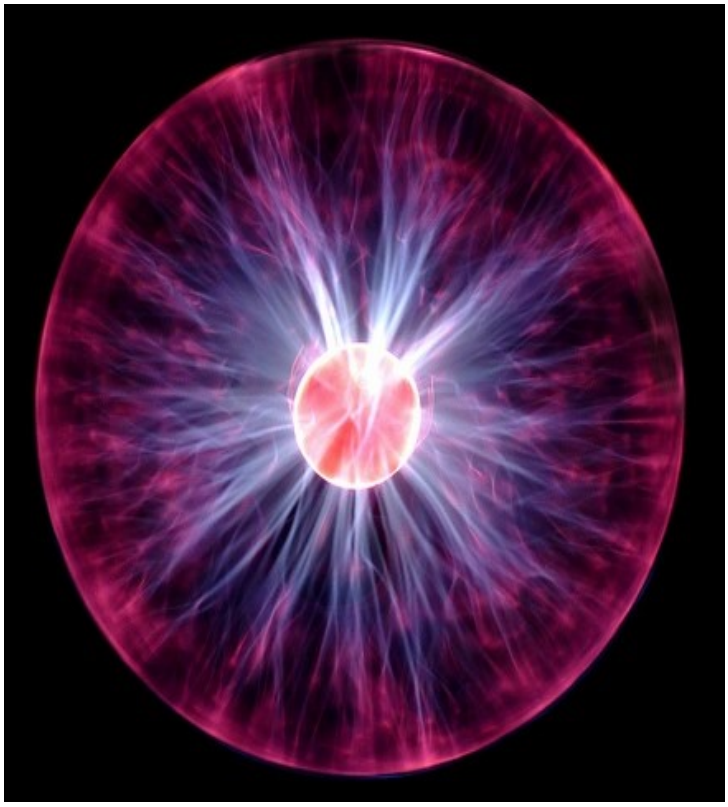
Year - 2019 - 20



ELECTROSPHERE

---- A Technical Magazine

Department of Electrical Engineering
AISSMS 's Institute of Information Technology, Pune.

Volume III

INDEX

DBMS Applications in Power Systems

Prof. Dr. Shashikant Bakre
Prof. Sachin Shelar

Introduction

In the advent of Information Technology, lot of IT based applications have been introduced in electrical power systems. Some areas are Load Flow Analysis, Fault Calculations, Harmonics Measurements, Network Synthesis, Smartgrids and Microgrids. Various tools available for these applications are Database Management Systems (DBMS), Knowledge Base Systems (Comprising of neural networks, artificial intelligence, expert systems, robotics and fuzzy logic based systems) and Object Oriented Web Enabled Systems. In this article we will have a discussion on DBMS applications in power systems.

Introduction to Database Management Systems (DBMS)

Data is referred as meaningful and reverent Information. In the context of electrical power systems, values of various parameters such as current, voltage, power, power factor, phase angle, energy and frequency may be a data. These parameters are measured by numeric meters and stored in Servers.

Data Files

The traditional way of storage of data is data files. Separate file is created to store data. The data file is connected to the file containing main program. In early days, the system engineers used to conduct load flow analysis in FORTRAN programming wherein separate data file was connected to the main program. Although it is easier to maintain data files, the main limitation of maintaining a data file is large amount of data cannot be stored.

File Management System (FMS)

The system comprising of number of data files is known as File Management System (FMS). The FMS is simple and easy to operate. However there is a problem of Data Inconsistency.
If the data file is sent from client side and before reaching server if the electricity is went off, the client side will indicate ‘data sent’ but server would indicate ‘data not received’ . This typical situation is called data inconsistency.

Database Management Systems (DBMS)

The problem of data inconsistency observed in case of FMS is handled successfully by Database Management System (DBMS). In DBMS, the user has to define a unit. The transaction (unit) would not be declared completed unless the definition is fulfilled.

For example, in above case if we define ‘data sent’ and ‘data receipt’ as one unit of transaction, then in the event of failure of power supply, the definition will not be fulfilled and

Transaction will show incomplete status. Thus data consistency and data integrity are the two main advantages of using DBMS.

Database is the collection of all such data. After collecting huge amount of data, we have to perform number of operations such as traversal, merging, sorting, searching, inserting and deleting. For this purpose a separate data management system is required called Database Management System (DBMS). Broadly there are here types of DBMS- Hierarchical (HDBMS), Network (NDBMS) and Relational DBMS (RDBMS). In a hierarchical DBMS, the data is stored in form of tree structure. For complex applications, HDBMS also becomes complex and difficult to analyze. Network DBMS comprises of data presentation in a network. During early 1970s, the HDBMS and NDBMS packages provided by International Business Machine (IBM) were well known. Today, RDBMS is the most popular and commonly used DBMS because of its ability to deal with complex data in a simple manner, data consistency and integrity discussed above. In RDBMS the data is arranged in form of rows and columns thus forming a tabular data structure. The heading of data is called field and data itself is called records. For example Table 1 shows Meter number, Manufacturer, Current Rating and Class of Accuracy as fields whereas dataitems such as HT-101, ABB, 5 A, 1 A, 0.5, 0.2 etc. are called records. The field using which corresponding data is opened is called unique key. For example Meter number is a unique field or unique key. As the name indicates, unique field is unique and cannot be repeated elsewhere in a table.For instance, HT-101 is a unique field as there is no other meter number than HT-101.

Table 1
Meter Database

Meter Number	Manufacturer	Current Rating	Class of Accuracy
HT-001	ABB	5 A	0.5
HT-002	L&T	1 A	0.2
HT-003	Secure	5 A	0.5
HT-004	Datapro	1 A	0.2

Table 2
MWh consumption recorded by the meter

Meter Number	Monthly MWh consumption recorded by the meter in six months in the year 2019					
	January	February	March	April	May	June
HT-101	1001	1050	1021	1037	1032	1063
HT-102	1676	1689	1607	1675	1645	1646
HT-103	1809	1876	1834	1822	1818	1867
HT-104	2012	2011	2016	2017	2066	2045

Table 1 gives meter database whereas Table 2 shows monthly Mwh consumption for the period of six months. It is quite possible to merge these two tables using unique key.

For this purpose, the command can be given through Structured Query Language (SQL).

Further if we want to identify consumers having monthly consumption above 1500 MWh, we can retrieve this information by entering condition like MWh>1500 MWh. Such questionnaire is called query. Such queries are entered in database through SQL.

The commonly used RDBMS packages are Oracle, SyBase, MySQL, MS Access, IBM DB2, MarialDB and Postgress. Among these packages, MySQL, MarialDB and Postgress are open source and available free of cost.

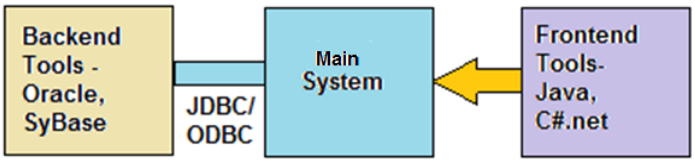


Fig 1
DBMS with Frontend and Backend tools

As shown in Fig 1, the database is interfaced with frontend tools and backend tools. The actual stored data is at backend. It is connected to the system through the bridge called Java Database Connectivity (JDBC) and Open Database Connectivity (ODBC). The connectivity between JDBC and ODBC is provided by JDBC-ODBC Bridge.

The SQL and high level programming languages such as Java, C#.net are provided as frontend tools. These languages perform various operations such as creation, traversal, merging, searching, insertion and deletion of records.

Use of Data Structures

The data structures can be used effectively in DBMS. Arrays, pointers, linked lists, trees, graphs; hash tables, bauble sort, quick sort, linear search and binary search techniques can be used effectively. The working of linked list is similar to the book having 1000 pages. In order to gather certain information, we link required pages of book by writing ‘go to page no ---‘ by pencil on previous page at the top. In this way, we can collect required information from 1000 page book through page numbers written on required pages using pencil. Similarly, if the list of 400 kV equipments is to be prepared, such equipments would be identified from huge database of all items having different voltage ratings. These item names are stored at various address locations in a computer memory. The address in memory locations pertaining to particular item would be identified. These equipment names would be connected through pointers addressing memory locations. This is called linked list. In this way, using linked list, the list of 400 kV equipments would be prepared from the large database of all electrical equipments.

Client Server Model for data storage

In AMR systems, the metering data is sent from Substations to Central Monitoring Stations (CMS) or State Load Dispatch Centers (SLDC) for all 27X7 hours. In Maharashtra State Electricity Transmission Co. Ltd (Mahatransco), the billing data required for ABT metering is sent from about 630 numbers of EHV substations to the CMS. This communication is based on Client-Server model wherein Substations are clients and CMS is server. The data is stored in DBMS server provided at CMS end. The data is also stored in a local server provided at client side.

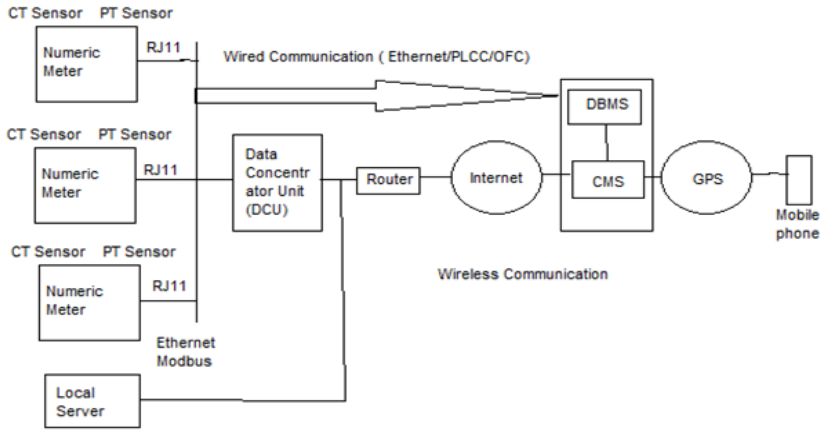


Fig 2
Data storage at Client and Server side

As shown in the figure 2, the data is collected by CT/PT sensors which are received by numeric meters. It is then sent to Ethernet modbus through RJ-11 connector provided at back side of the numeric meter. Thereafter the data is collected by the device called Data Concentrator Unit (DCU). Then it is sent to CMS and later to Mobile phone. There are two channels of unidirectional communication- wired and wireless. The wired communication is conducted through Ethernet, PLCC and OFC whereas wireless communication is arranged through internet and GSM media. In this manner, the data is stored at client side local server and server side CMS DBMS server.

Data warehouse and Data Mining

The DBMS discussed above is limited for a structured database wherein the specific fields and records are available. It would provide information only as per quarries. However, it is not suitable for unstructured database. On number of occasions, unstructured dataitems are required to be included and retrieved as needed. Some examples of unstructured database are Audio/video clips, animations, images, pictures, reviews and profiles. Data warehouse is a system in which structured and well as unstructured data can be stored. Retrieval of such type of data items is not possible through SQL or any other frontend tool. Data Mining is the application software using which required data can be retrieved from the Data Warehouse. Some of the Data Mining software packages are Oracle Data Mining, Microsoft SharePoint, Suspense and Rapid Miner.

MSEDCL New Tariff (September 2019) Review

Prof. Sachin V. Shelar

MERC has approved the new tariff of Maharashtra State Electricity Distribution Company Limited (MSEDCL) from the September 2018

Major Highlights are as below:

1. Introduction of penalty for lead kVARh
2. Reduction of power factor incentive from 7% to 3.5%.
3. Introduction of kVAH billing from 1 April 2020.
4. Creation of new Tariff Category – Electric Vehicle under HT Level
5. Increase in fixed charges from 350/- per kVA to 391/- per kVA

Summary of HT Tariffs for FY 2019-20, effective from 1 April, 2019

Category	Fixed/Demand Charge		Energy Charges	Wheeling Charges	Total Variable Charges
	Unit	Rate	Rs/kWh		
HT Category - 11 kV					
HT I (A) (i): HT - Industry	Rs./kVA/Month	391.00	7.07	0.76	7.83
HT I (B): HT - Industry (Seasonal)	Rs./kVA/Month	391.00	7.34	0.76	8.10
HT II : HT - Commercial	Rs./kVA/Month	391.00	11.73	0.76	12.49
HT III : HT - Railways/Metro/Monorail Traction	Rs./kVA/Month	391.00	7.00	0.76	7.76
HT IV: HT - Public Water Works (PWW)	Rs./kVA/Month	391.00	6.30	0.76	7.06
HT V(A): HT - Agriculture - Pumpsets	Rs./kVA/Month	69.00	3.77	0.76	4.53
HT V(B): HT - Agriculture - Others	Rs./kVA/Month	69.00	5.20	0.76	5.96
HT VI: HT - Group Housing Societies (Residential)	Rs./kVA/Month	313.00	5.82	0.76	6.58
HT VIII(A): HT - Temporary Supply Religious (TSR)	Rs./kVA/Month	418.00	3.75	0.76	4.51
HT VIII(B): HT - Temporary Supply Others (TSO)	Rs./kVA/Month	391.00	12.00	0.76	12.76
HT IX(A): HT - Public Services-Government	Rs./kVA/Month	391.00	7.90	0.76	8.66
HT IX(B): HT - Public Services-Others	Rs./kVA/Month	391.00	9.70	0.76	10.46
HT X: HT – Electric Vehicle Charging Station	Rs./kVA/Month	70.00	5.24	0.76	6.00

Power Factor Computation Formula

$$Avg\ PF = \frac{Total\ kWh}{Total\ kVAh}$$

Wherein

$$kVAh = \sqrt{\sum (kWh)^2 + \sum (RkVAH\ Lag + RkVAH\ Lead)^2}$$

It can be seen that as lead RkVAH are being considered, customer having lead power factor (over compensation) will have lower power factor, so they may get less incentive or penalty.

Power Factor Incentive:

Sl.	Range of Power Factor	Power Factor Level	Incentive
1	0.951 to 0.954	0.95	0%
2	0.955 to 0.964	0.96	0.5%
3	0.965 to 0.974	0.97	1.0%
4	0.975 to 0.984	0.98	1.5%
5	0.985 to 0.994	0.99	2.5%
6	0.995 to 1.000	1.00	3.5%

Power Factor shall be measured/computed upto 3 decimals, after universal rounding off.

Power Factor Penalty:

Whenever the average **PF is less than 0.9 (lag or lead)**, penal charges shall be levied at therate of the following percentages of the amount of the **monthly electricity bill, excluding Taxes and Duties:**

Sl.	Range of Power Factor	Power Factor Level	Penalty
1	0.895 to 0.900	0.90	0%
2	0.885 to 0.894	0.89	1.0%
3	0.875 to 0.884	0.88	1.5%
4	0.865 to 0.874	0.87	2.0%
5	0.855 to 0.864	0.86	2.5%
6	0.845 to 0.854	0.85	3.0%
7	0.835 to 0.844	0.84	3.5%
8	0.825 to 0.834	0.83	4.0%
9	0.815 to 0.824	0.82	4.5%
10	0.805 to 0.814	0.81	5.0%
...	...	...	...

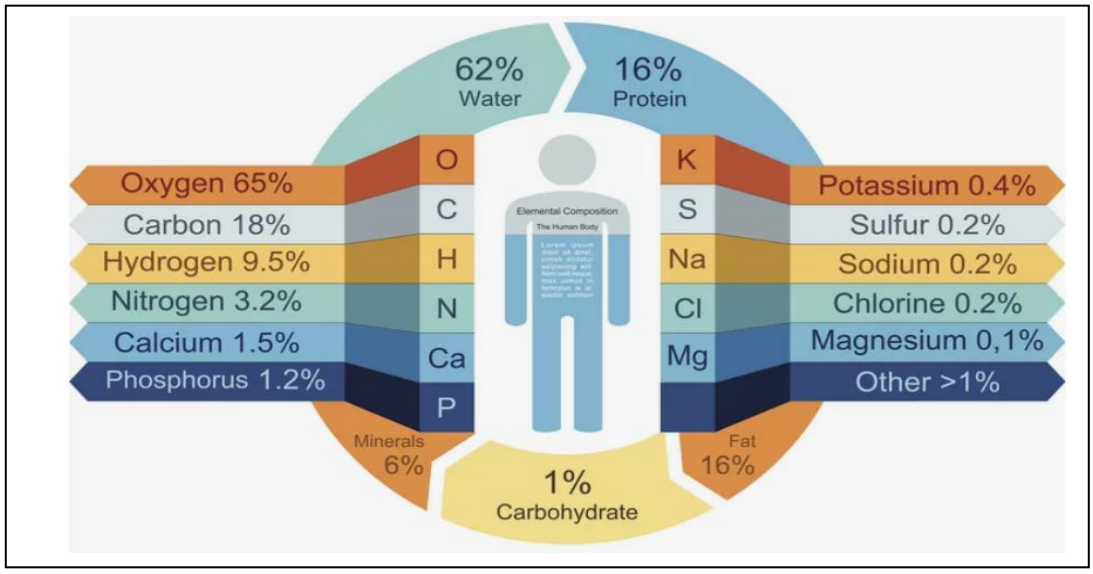
❑❑❑

Human Body as A Generator of Electricity

By Sandeep M.Chaudhari

The human body is a good generator of electricity. I would like to support these statements by giving some facts and examples.

Elements of human body



The water content is dominant part almost 62 % . The protein is 16%

Almost 99% of the mass of the human body is made up of six different elements. These are oxygen, carbon, hydrogen, nitrogen, calcium, and phosphorus. Only about 0.85% is composed of another five elements: potassium, sulfur, sodium, chlorine, and magnesium.

The electrical conductivity in S/m (Siemens per meter) of some of the elements is shown in table-1

Potassium	1.4×10^{7} S/m
Carbon	100000 S/m
Calcium	2.9×10^{7} S/m
Phosphorus	1×10^{7} S/m
Sodium	2.1×10^{7} S/m
Magnesium	2.3×10^{7} S/m
Chlorine	0.01 S/m

Element/Part of human body	**Electrical Conductivity S/m**
Skin	0.5
Fat	0.036
Vessal Wall	0.46
Blood	0.35
Muscle	0.7
Bone	0.17

From table 1, it is observed that most of the elements are having good conductivity.
The electrical conductivity of human body elements is given in table-2.It can be concluded that there are ample parts in our bady which have reasonable electrical conductivity.

How Human Body functions as a Generator of Electricity?

For electrical generator there are basic three things required-Magnetic fielld,Conductor and relative motion between conductor and magnetic field. Now these requirements of generator functioning are fulfiled due to Mother Nature and us (human body).
In simple words these are fulfilled in following way-

- **Magnetic field**-Magnetic field of Earth around us
- **Conductor**- Blood in veins of humanbody which is a good conductor due to the costituents present in blood
- **Relative motion between conductor and magnet**- The herart continuously circulated blood in our body hence motion of conductor is ensured.

The above 3 elements related to human body generator are discussed in following sections

Magnetic Field-Earth as a giant magnet

We live on earth. The Earth is a giant magnet . The magnetic field of Earth is extremely important to sustaining life on Earth. Without it, we would be exposed to high amounts of radiation from the Sun and our atmosphere would be free to leak into space.
There is lot of iron material inside earth surface in the form of molten lava . The chemical irrugilarites between different constituents in this molten material cause currents to flow.**Note-Earth is not a permanent magnet, but an electromagnet.**

In following table some diagrasms illustrate the earth's magnetic field

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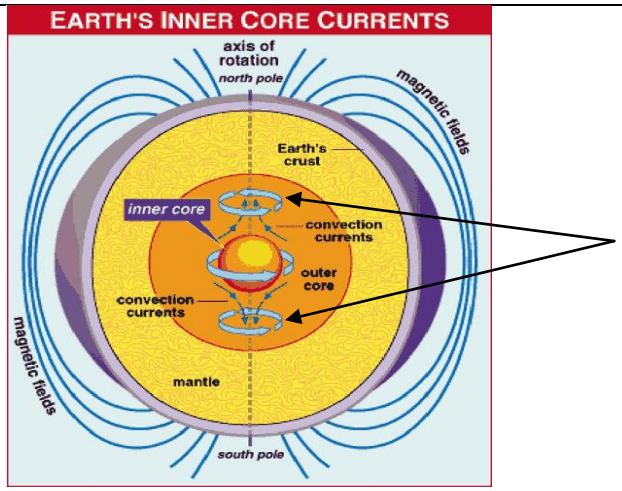
<tr>
<td> 
</td>
<td>Parts- Inner core,Outer core,Earth's crust
Due to chemical irregularities in the molten lava,different chemical compositions of solid materis inside Earth's surface, churning mass etc,the currents are generated ,these are often termed as eddy currents.These move in circular path as shown.
And due to flow of these circular path currents throughout the Earth's mass,magnetic field is generated bty Earth.</td>
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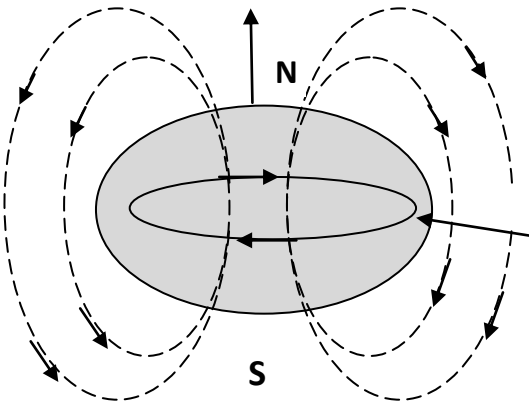
<td> 
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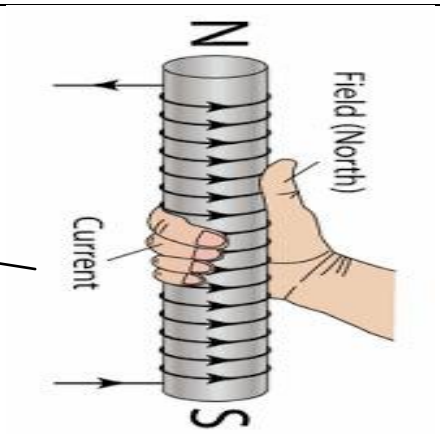
<td> 
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<tr>
<td colspan="2">It can be seen how the currents within Earth's surface generate magnetic field , right hand rule is applied to determine the direction of Earth's magnetic field.Thus N-S poles are generated by Earth.</td>
</tr>
</table>

Conductor-Vein and blood system

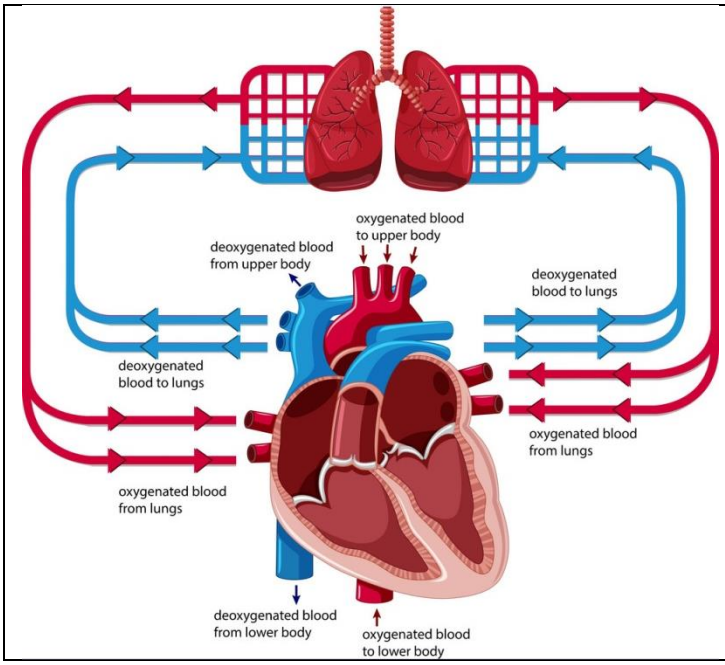
Veins are blood vessels that carry blood toward the heart. Most veins carry deoxygenated blood from the tissues back to the heart. The walls of veins are made up of three different layers:

- **Tunica externa**. This is the outer layer of the vein wall, and it's also the thickest. It's mostly made up of connective tissue. The tunica externa also contains tiny blood vessels called vasa vasorum that supply blood to the walls of veins.

- **Tunica media.** The tunica media is the middle layer. It's thin and contains a large amount of collagen. Collagen is one of the main components of connective tissue. The electrical conductivity of collegian is about 35 S/m at 30 degree centigrade.
- **Tunica intima.** This is the innermost layer. It's a single layer of endothelium cells and some connective tissue. This layer sometimes contains one-way valves, especially in the veins of arms and legs. These valves prevent blood from flowing backward.

The blood is a good conductor of electricity. The specific conductance of blood varies in the range of 7 to 15 Mho .cm X 1000.

Motion of conductor- Blood flow



The human circulatory system consists of a network of arteries, veins, and capillaries, with the heart pumping blood through it. Its primary role is to provide essential nutrients, minerals, and hormones to various parts of the body. Alternatively, the circulatory system is also responsible for collecting metabolic waste and toxins from the cells and tissues to be purified or expelled from the body

Thus the 3 conditions required to generate electricity are fulfilled by human body i.e.

i) Magnetic Field-Earth as a giant magnet
ii) Conductor-Vein and blood system
iii) Motion of conductor- Blood flow

The magnetic field of Earth is cut by blood (moving conductor) and emf is generated in it which circulates current in our body. This generated electrical power is utilised by human beings for their activities and living.

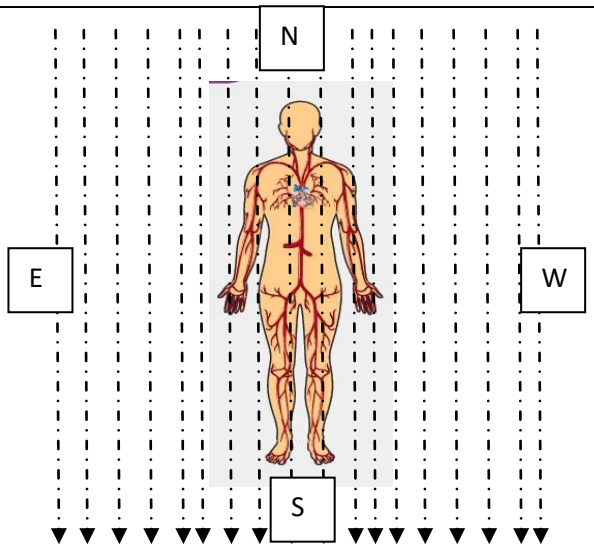
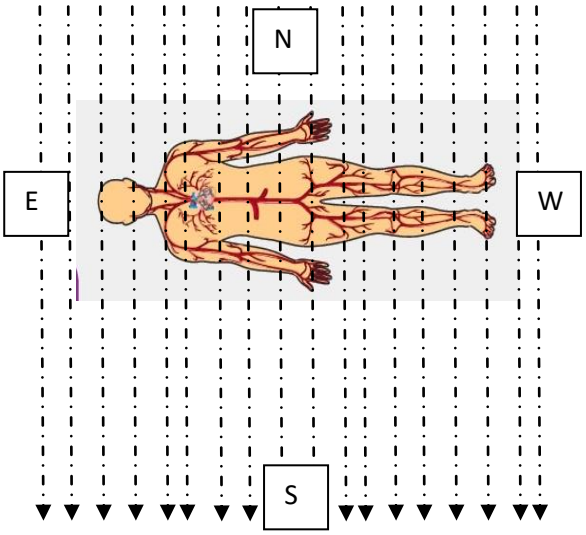
Few examples will support the facts that human body is a generator of electricity-

Sleeping position

Our grandparents always ask us to sleep along East –West direction and not along North-South direction. Why?

Because if we sleep along North-South direction then the blood conductor will cut very few lines of magnetic flux (Earth's Mmagnetic flux) and less EMMF will be generated. Hence we feel doziness or lack of freshness when we wakeup.

But if we sleep along East-West direction then the blood conductor will cut very maximum amount of lines of magnetic flux (Earth's Mmagnetic flux) and more EMF will be generated. Hence we feel enthusiasm or freshness when we wakeup.

 Earth's magnetic field	 Earth's magnetic field
Sleeping direction –Along North-South-Less flux cutting,Less generation of electrical energy	Sleeping direction –Along East-West-Less flux cutting,Less generation of electrical energy

Power Generated by Human brain-

Almost 15 to 20% blood flow is for brain. It is experimentally proved that an average adult brain produces 40 to 60 watt power.

Effect of Full Moon (Pournima) and dark moon (Amavasya) on human body

We all are aware of effect on Moon's magnetic field on Earth's magnetic field.On the day of Amavasya the Moons magnetic field interacts with Earth's magnetic field in such a way that the net magnetic field reduces. Hence human body generator generates less electrical energy. Our parents, grandparents do not permit us to go for outing ,particularly in night hours during Amavasya (Dark moon day).

ON the Pounima (Full Moon Day) the Moons magnetic field interacts with Earth's magnetic field in such a way that the net magnetic field is more. Hence human body generator generates more electrical energy. We often celebrate our festivals like Kojagiri pounima etc on these days . This is because our human body generator is surrounded with more magnetic flux and more energy is generated it gives us positive energy.

Electromagnetic waves from human body

Since there is flow of electric current in the human body, it also has magnetic field around it. We if sound of any radio is not clear, we move our hand on it or put our hand on it. And most of the times, the sound becomes clear as we do it.
This happens because the magnetic field of human body generator interacts with it.

Wavelength matching

We often make a statement that, I am not comfortable with this person or our wavelengths don't match. Well the internal composition of every human is different so the magnetic field generated by every human body is different. These magnetic field interact and that decides the wavelength matching.
I have tried to put this topic as a part of imaginary thing or fiction. The author does not claim that the every statements made in above article have any experimentation or scientific evidences. Some facts and figures although have evidence of literature. Its just about imagining things around us in some different way.

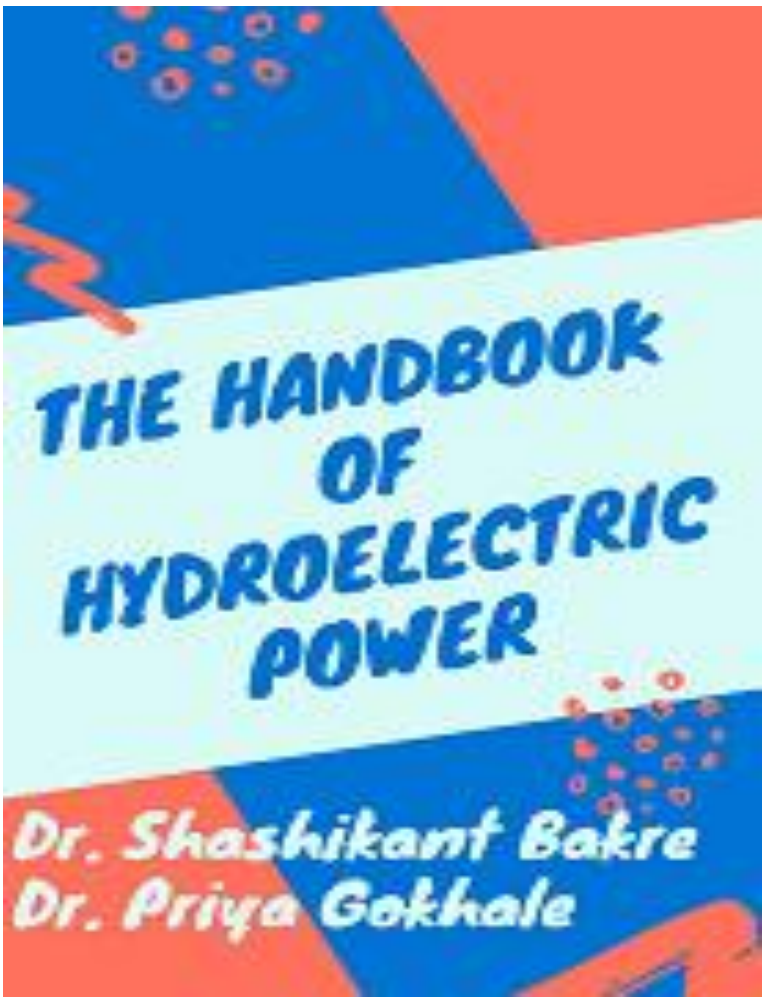
Publication of book on Hydroelectric Power

Prof. Dr. Shashikant Bakre

The book titled “The Handbook of Hydroelectric Power “written by Prof. Dr. Shashikant Bakre has been published on 11th October 2019.

The book was published by IST Publishing House and distributed by Amazon Publishers worldwide. The book is available for readers in e-book and paperback formats. The book is coauthored by Prof. Dr. Priya Gokhale.

As we all know, electricity is an essential ingredient in our daily life. As per demand, electricity is generated as it cannot be stored economically. It is observed in number of cases that the load is ahead of generation. This book illustrates basics of generating electricity with hydroelectric power generation in particular. Hydroelectric power is reliable, quick starting and pollution free type of generation. It can be used as bulk generation in Smartgrids as well as distributed generation in Microgrids. The recent developments in hydropower generation are also discussed in this book.



14th Edition
ELECRAMA
we are all about electricity
18–22 JANUARY 2020
INDIA EXPO MART, GREATER NOIDA, NCR, INDIA
Electrifying 30 years
1990 - 2020

Prof. S. D. Raste

About ELECRAMA:

ELECRAMA is a platform to connect the world with Indian industry in respect of technology, new trends and innovation for future energy transition. It is also a stage where all global leaders can meet and share their ideas to develop cost effective solutions for the world. India is expected to become the fifth largest Economy in the world by the end of 2025 and we invite our global counterparts to be partner in our growth story.

Anil Saboo
Chairman, ELECRAMA 2020

Overview:

ELECRAMA brings together the complete spectrum of solutions that powers the planet from source to socket and everything in between. Featuring not just equipment & technology, but peerless thought leadership platforms for everything electric - from technical conclaves to industry summits.

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- **Presence of global majors to small scale manufacturers –** The entire value chain to strengthen supply chain, logistics & vendor capability assessment.
- Deeper & **direct trade engagement with buyers and sellers** through purpose built events.
- Preview **new and upcoming product & technology**, new specs & standards.
- Explore investment opportunities & closer view of **Multi billion dollar Indian Power Sector**.
- **Professional & peer networking** across the globe and hierarchies through dedicated networking events.
- **Knowledge Sharing & Career Advancement** through seminars, symposia and conferences.

PROJECTIONS FOR ELECRAMA 2020:

- 1300+ exhibitors
- Gross area of 1,10,000 Sq Mtrs
- 450 foreign exhibitors
- Overall participation from 120 countries
- More than 1.5 billion USD of business to be generated
- 3,50,000+ footfalls over five days.

WHY SHOULD YOU BE HERE?

- Largest congregation of power sector ecosystem in the geography.
- Widest Choice of product and technology across the spectrum on display – over 221 Transformers, 321 Cables & Conductors, 202 Control & Switchgear, 113 Instruments & Instrumentation amongst others.
- Presence of global majors to small scale manufacturers – the entire value chain to strengthen supply chain, logistics & vendor capability assessment.
- Deeper & direct trade engagement with buyers and sellers through purpose built events.
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Organizers:

Indian Electriacal & Electronics Manufacturers' Association (IEEMA)

IEEMA is the apex association of manufacturers of electrical, industrial electronics and allied equipment in India. Founded in 1948, IEEMA is the first ISO certified industry association with 800+ member organisations encompassing the complete value chain in power generation, transmission and distribution equipment.

IEEMA members contribute to more than 90% of the power equipment installed in India and represent a turnover of over USD 25 billion. IEEMA has a pan India presence with its corporate office at New Delhi, registered office at Mumbai, regional offices at Kolkata and Bangalore and eight state offices.

R.K. Chugh, President – IEEMA
Vipul Ray, Sr. Vice President – IEEMA
Rohit Pathak, Vice President – IEEMA
Sunil Misra, Director General - IEEMA

Arduino Based PWM DC-DC Boost Converter for Traction System

Nilambari V. Devarkar, Ashpana Shiralkar

Abstract: ***Now a day's energy conservation is the most important thing in the world wide. The area of traction also take this into the consideration, so they take a step forward to use regenerative energy which is generated through the regenerative braking in the train. This regenerated energy most of the time get wasted in form of heat. Or most of the time it fed back to overhead equipment. Using regenerative braking energy battery energy storage system is charging used in many countries like japan, New Zealand, UK. This paper presents the implementation of a dc dc boost converter which used this regenerated energy in the traction system and boost the voltage of battery energy storage system. This paper presents the improved dc-dc boost converter which can be implemented in future in the Indian railways system. Arduino based PMW dc dc converter used in traction system to charge the battery energy storage system.***

Index Terms: DC-DC boost Converter, Arduino, PWM, regenerative energy, traction system.

I. INTRODUCTION

Past several years because the industry grownup, so fast that needs of everyone completely different like cost should be minimum, life span more, quality etc. ,to retain with these demands engineers have worked towards developing economic conversion practices related required proper growth of an knowledge domain field of power electronics. Power electronics industry capture worldwide as due to above mention benefits. Power electronics made world a compact place due to numerous changes day by day. Dc dc boost converter used in the many applications from medical to aerospace. This converter used where dc output is required. DC-DC boost convertor output voltage is higher than the input voltage. DC-DC boost convertor play a vigorous role. In this paper energy storage element used is MOSFET and combination of both L and C are used. MOSFET switch in the boost converter is turn on by using PWM TL494. Arduino microcontroller is used with PWM to generate the pulses and control of the output voltage of the dc dc boost converter. DC DC Boost converter required DC supply here adapter is used which gives DC supply to DC DC boost converter. Now in Indian traction system regenerative energy is used in WAP-5, WAP-7 and WAG-9 class of 3phase locomotives. These locomotives are saving up to 20% and 3phase electrical multiple units (EMU) are saving up to 30% energy through regenerative braking. This energy can be used to charge the battery energy storage system in railways with the help of dc dc boost converter. Recently Indian railways not use this regenerative braking energy to charge the battery, but in the future this improved dc dc boost converter will not only reduced energy consumption by using regenerative braking energy also reduced CO_2 emission.The paper is structured as follows in the section I introduction of power electronics. Section II system configuration is introduced section III simulations and result of model presented. Section IV is the conclusion part.

II . SYSTEM CONFIGURATION

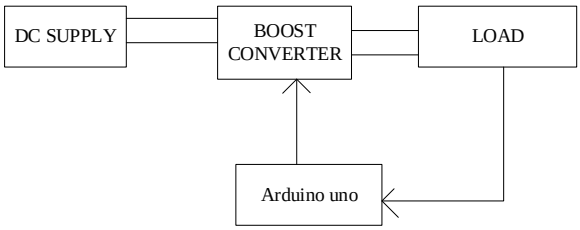

Figure 1 block diagram of Boost converter prototype model

Figure 1 shows the block diagram of prototype model of dc-dc boost converter proposal for traction system. Prototype model used dc –dc boost converter which is used to boosted the output voltage. Lead acid battery of 14.2 V is used as battery energy storage system in the prototype model of traction system. Arduino based PWM controller is used to control the output of converter up to 14.2 V.PWM generate pulses so that MOSFET switch on hence in this way it control the output of converter by controlling duty cycle of it. Specification DC –DC Boost Converter output voltage 14.2V. ARDUINO UNO ATMEGA328P-PU controller is used. A MOSFET used as switching element in this project. 12V supply is used as a source. MOSFET (IRFZ44E), inductance (0.28mH), capacitance (100nf) and diode (IN4407) are used in the circuit. These are the dc dc boost converter parameters. TL494 PWM have a facility called direct MOSFET driving means it doesn't need additional driving circuitry. It can directly ON and OFF MOSFET.

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III. SIMULATION AND RESULT

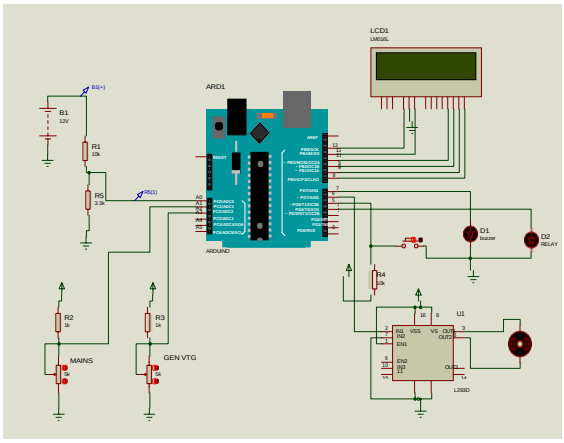

Figure 2 Proteus simulation

Figure 2 shows the proteus simulation. First the program should be burned into Arduino controller .Input voltage may vary to any value but with the help of PMW TL494 duty cycle of this adjusted through arduino Uno. In this ardunio controller shows three voltages on display 1. Generated voltage 2. Battery voltage 3. Mains voltage designing a prototype model for traction system where we can use this dc-dc boost converter to charge the battery. In japan due to natural disaster train stop at one point to avoid such kiosk japan implement the battery energy storage system. Here trying to implement prototype model of train so we need battery storage system in which energy can be stored and use this energy in any natural disaster condition. We need 12 V battery, to charge this dc-dc boost converter is used which charge the battery up to 14.4V to maintain the output voltage constant we use PMW TL494 with ardunio controller. By controlling duty cycle output voltage of boost converter maintain constant for any change in input voltage. Here ardunio controller play key role. This controller shows three voltages: Generated voltage, Battery voltage and Mains voltage. Normally battery of railways charged through 25KV catenary overhead supply. Rectifier house is near to each station. Regenerative energy generated from braking action is normally fed back to OHE, here we are going to use this regenerative power from braking action to stored charge in the battery. In the prototype model figure 3 shows ,if mains are available ardunio show mains voltage.

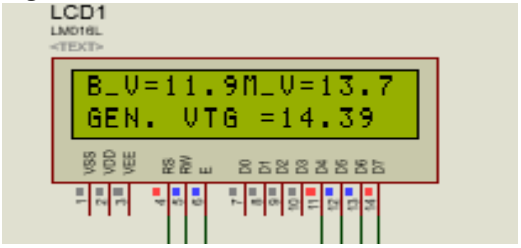

Figure 3. Mains supply is available

Figure 4 shows, if supply cut it shows traction system on battery

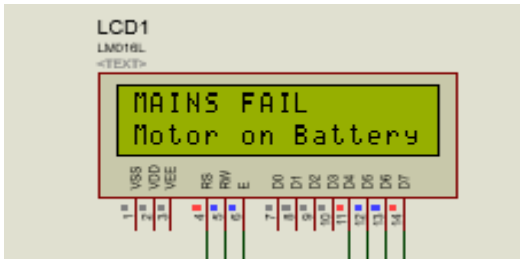

Figure 4 mains fail

Figure 5 shows that it keep on searching near station to stop.

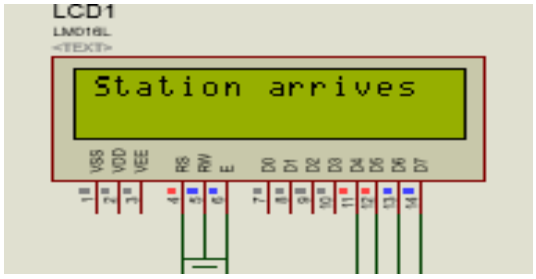

Figure 5 Station arrive

IV. MAIN CIRCUIT TESTS

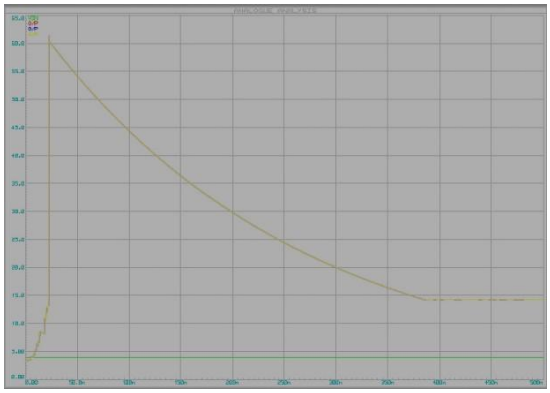

Figure 6 voltage vs. distance

As shown in figure 6, as input voltage increases output voltage remains constant that is 14.2 V.it also shows the distance with respect to voltage.

V. CONCLUSION

This paper is the implementation of such DC-Dc Boost converter which charges the battery with the help of arduino Uno and PMW. Output voltage of converter remains same that is 14.2V. This is the simplest way to regulate the dc output voltage. This DC-DC boost converter for charging battery in the traction system which not only used regenerative energy but also co2 emissions reduces. This dc dc boost converter used near future in Indian railways where this regenerative braking energy charged the battery energy storage system and used if mains supply fail or any other problem due to DC feeder or mains get isolated that time it helps the train to travel near station within the reach.

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IMPLEMENTATION OF 15 LEVEL 10 SWITCH DC SOURCE SWITCHED INVERTER AND COMPARISON OF ITS PARAMETER WITH 15 LEVEL 16 SWITCH H-BRIDGE INVERTER BY SIMULATION.

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Abstract : Harmonic content is one of the most important aspects of multilevel inverters. Total harmonic distortion (THD) is directly proportional to number of switches used to convert DC to AC and inversely proportional to number of levels in output voltage waveform. The amount of harmonics introduced in switched DC source 10 switch inverter (proposed) is lesser as compared with those of common multilevel inverters. In this paper a system using 10 switches to generate 15 output levels for getting less distorted and smooth waveform is implemented. Less switches leads to less switching time and improved system. Also it reduces the complexity and cost of the system. 3 DC voltages (6V,12V,24V) are used to produce 15 output levels. The system is simulated in MATLAB simulation. A comparison in MATLAB is done between Cascaded H-bridge 16 switch 15 level inverter and Switched DC source 10 switch 15 level inverter for output voltage, output current and THD.

IndexTerms **- Total harmonic distortion (THD), Multilevel Inverter (MLI), harmonics**

I. INTRODUCTION

The Inverter is an electrical device which converts direct current (DC) to alternate current (AC). The inverter is used for emergency backup power in a home and industrial applications. The inverter is used in some aircraft applications to convert a portion of the aircraft DC power to AC. The AC power is used mainly for electrical devices like radio, motor, lights, radar and other devices. The many industrial applications require very high power for their operations. Some appliances in the industries however require medium or low power for their different operation. By Using a high power source for all industrial loads may prove beneficial to some motors requiring high power, while it may damage the other loads. Some medium voltage motor drives and utility applications require medium voltage for operation. The multilevel inverter has been introduced since 1975 as alternative in medium voltage and high power situations. The Multilevel inverter is like an inverter and it is used for industrial applications as alternative in medium voltage and high power situations.

Multilevel inverter technology is a very important alternative in high-power and high voltage applications. They have a unique structure which makes it possible with less harmonic content. Harmonic content of the output waveform decreases as the number of output voltage level increases. Research is going on to enhance their capabilities further through optimized control techniques, and to minimize both component count and manufacturing cost. The main advantages are lower Total harmonic distortion (THD) and less stress on power switches and higher efficiency. The multilevel inverters are used in motor drives, power conditioning devices, renewable energy generation and distribution.

II. PROPOSED ARCHITECURE

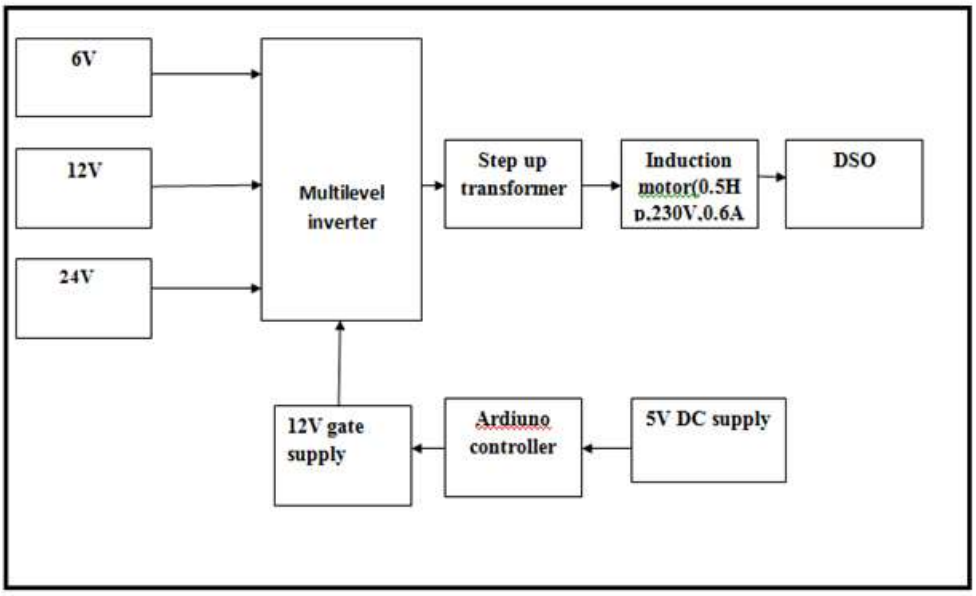

Fig 1 Block diagram of proposed system

6V, 12V and 24V are separate DC sources used in this system. This are fed to the control logic and a series of switches which comprises the inverter. The output is 15 different levels of AC output. Inverter consists of

1. Switches: there are 10 switches present in this system. The MOSFET switches are used in this system since they can handle large power and are more accurate than any other type like IGBT or conventional transistor type (NPN or PNP).
2. Control logic: control logic is used to control the state of switch.

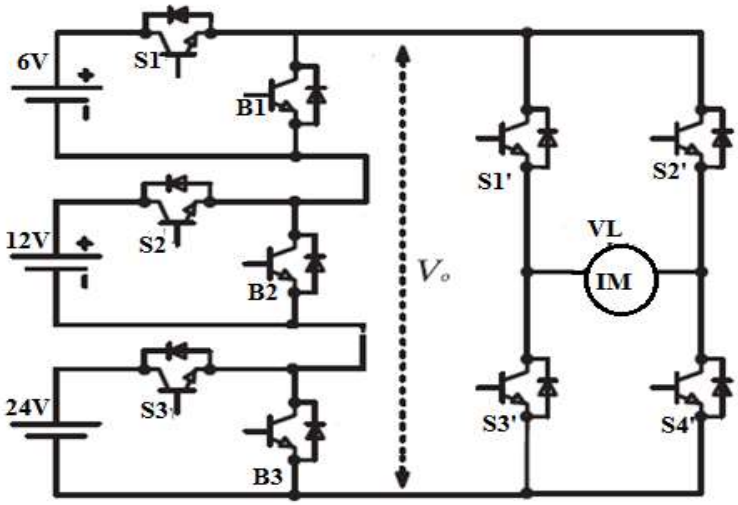

Fig 2 circuit diagram of proposed system

Fig 5.2 shows the circuit diagram of (E-Type) Asymmetric Multilevel Inverters with Reduced Components. The circuit diagram includes 10 Switches namely S1,S2,S3, B1,B2,B3,S1',S2',S3',S4'. The switches are made up of MOSFET (metal oxide semiconductor field effect transistor), we are using this switches to convert input to 15 levels AC output. DC power supply for proposed circuit diagram where 6Volt, 12 Volt and 24 Volt.

Hardware components :

1) MOSFET
2) DC power supply (Batteries)
3) Transformer
4) Opto-coupler
5) Oscilloscope
6) Ardiuno (controller)
7) Induction motor

Working: A multilevel inverter with 10 switches operate with DC batteries. Arduino as controller is programmed for switching sequences of MOSFET. DC batteries gives gate supply and Circuits starts .Alternate switching turn on and off , of switches takes place. Inverter generate 42V Ac voltage. This 48V AC voltage is step up to 230V using a transformer to run an induction motor. The output voltage waveform of 15 level is observed on DSO.THD is measured through power analyzer.

III. HARDWARE

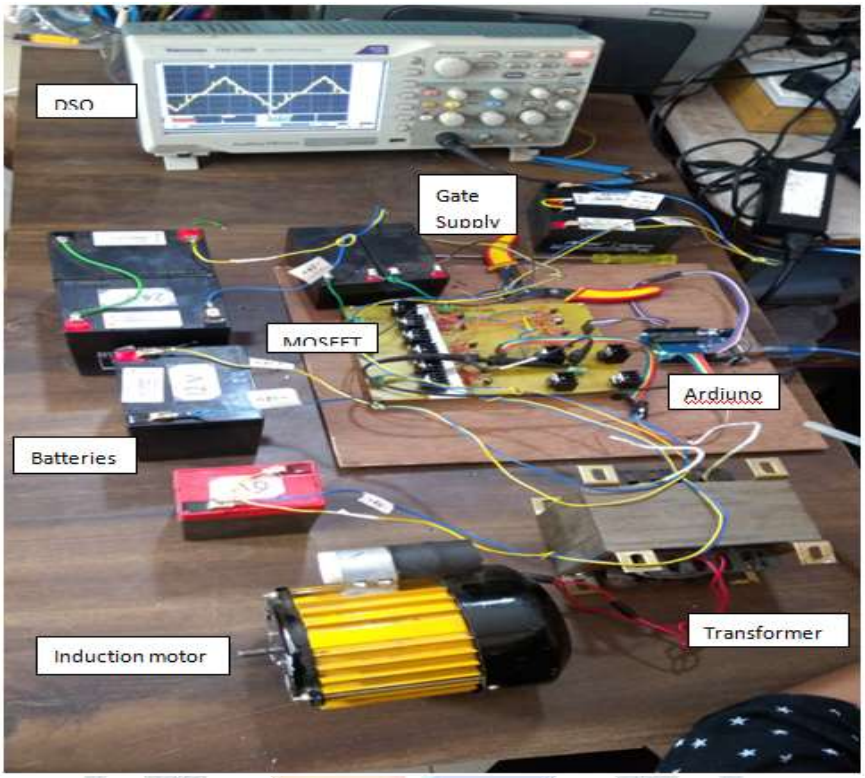

Fig 3 hardware model of proposed system

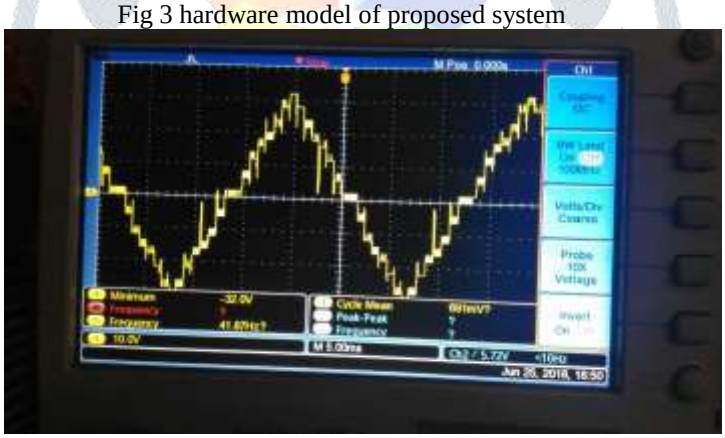

Fig 4 output voltage waveform on DSO

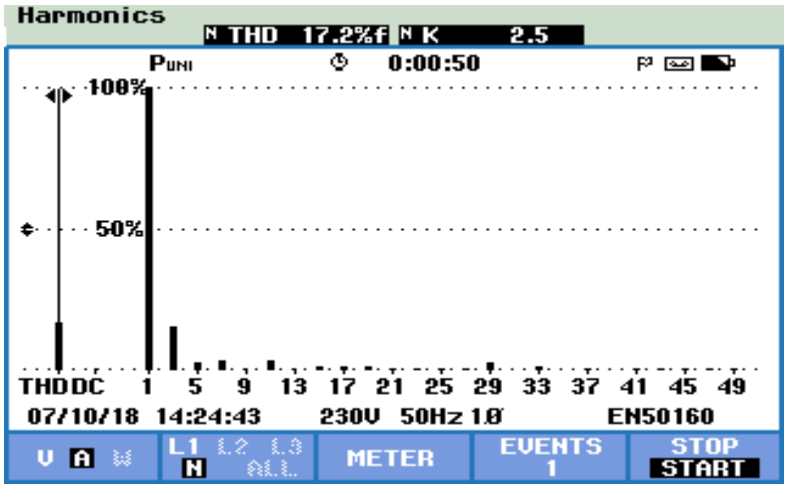

Fig 5 THD in output voltage of 10 switch inverter on harmonic analyzer

Table 1 Hardware results

SR.No	Quantity	Value
1	RMS voltage [Vrms]	16.73V
2	Maximum voltage	32V
3	Minimum voltage	-32V
4	Peak to peak voltage	64V
5	Frequency	41.89Hz
6	THD	17.2%

IV. SIMULATION

1) Simulation diagram for Cascaded H-Bridge 16 switch inverter

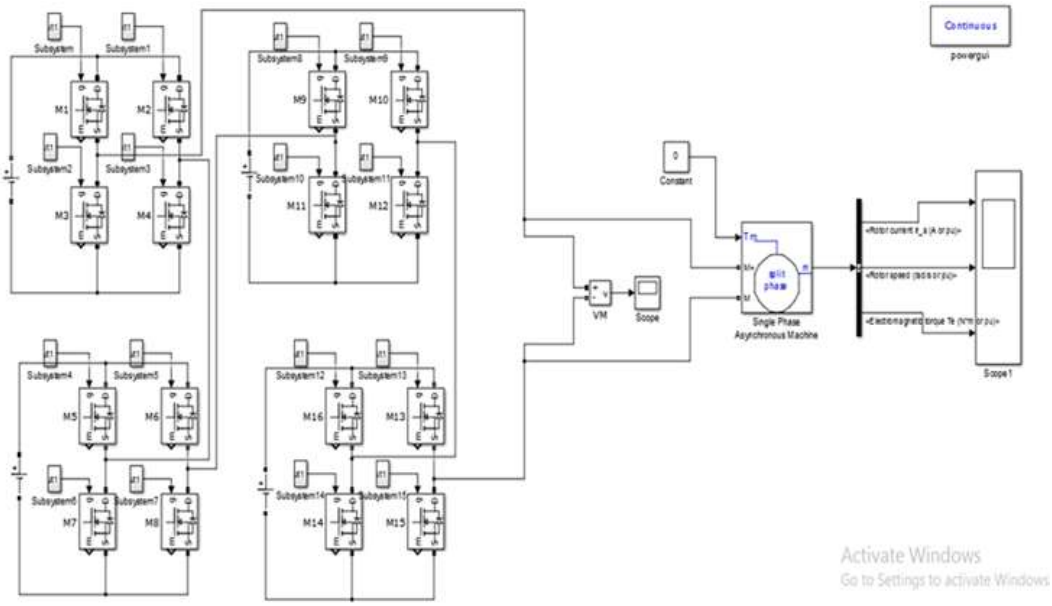

Fig 6 MATLAB simulation diagram for Cascaded H-bridge 16 switch inverter

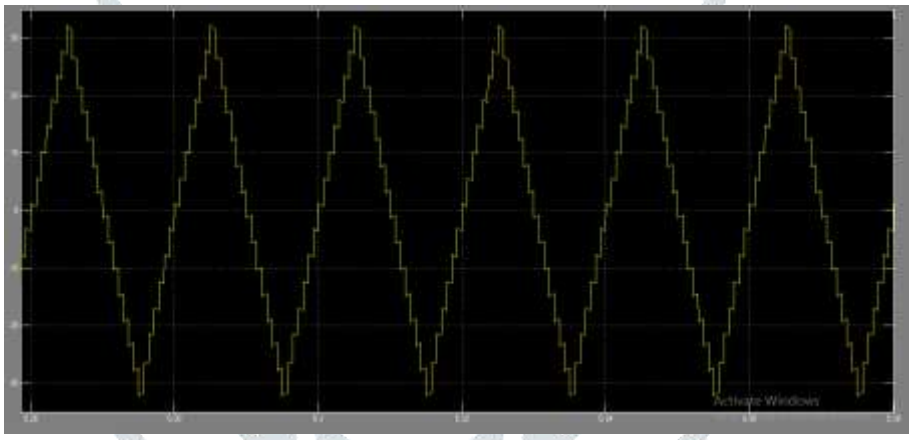

Fig 7 Output voltage waveform for 16 switch multilevel inverter

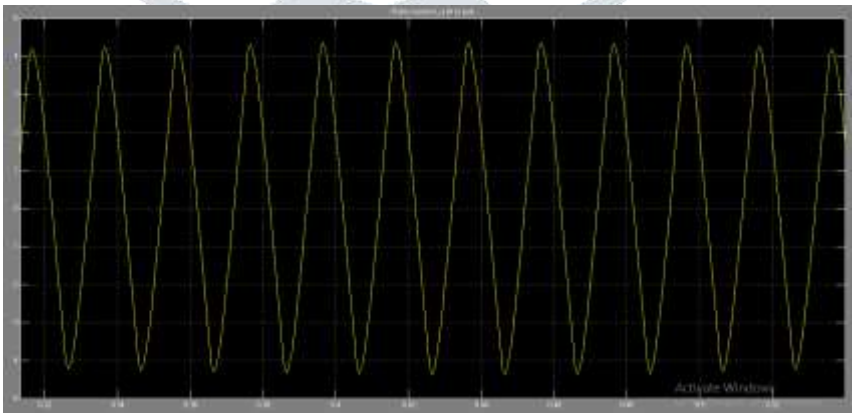

Fig 8 Output current waveform for 16 switch multilevel inverter

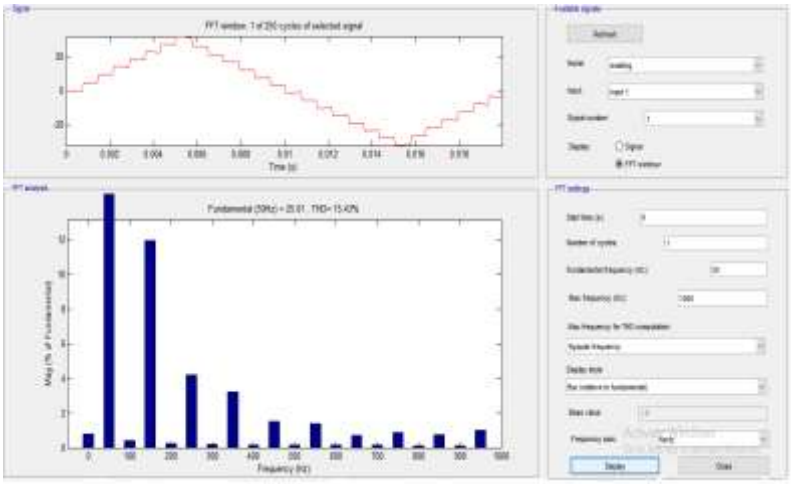

Fig 9 FFT analysis for 16 switch inverter

Table 2 simulation result for 16 switch multilevel inverter

SR.No	Quantity	Value
1	R.M.S voltage[Vrms]	22.63V
2	R.M.S Current [Irms]	2.89 Amp
3	Maximum voltage[Vmax]	32V
4	Minimum voltage [Vmin]	-32V
5	Peak to Peak Voltage [Vpp]	64V
6	THD	15.43%

2) Simulation diagram Switched DC source 10 switch inverter

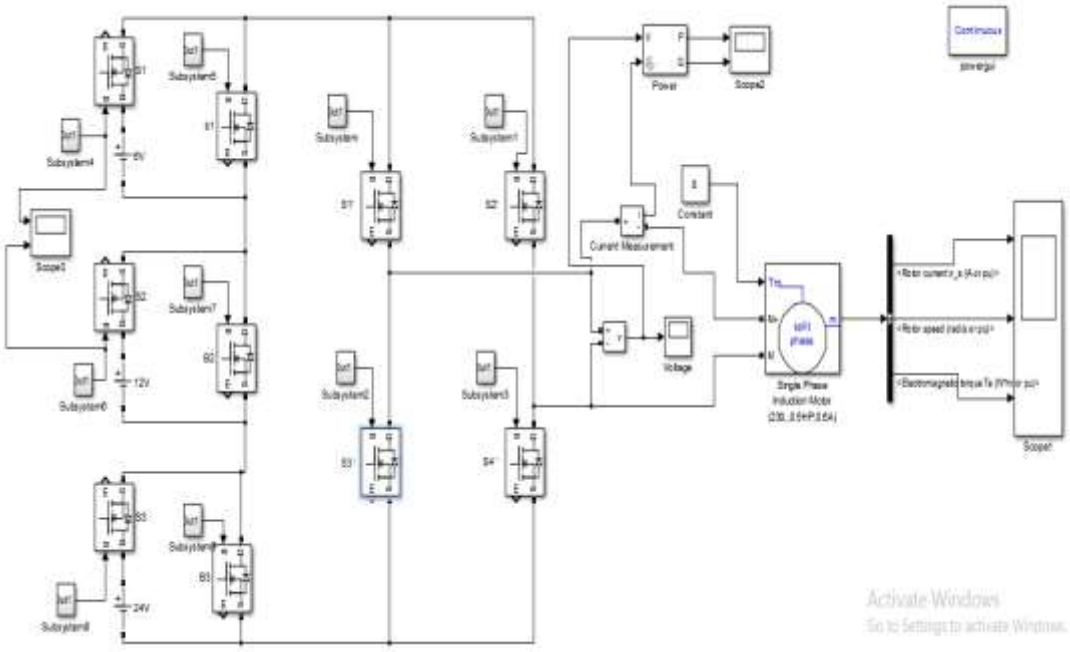

Fig 10 simulation diagram for 15 level 10 switch multilevel inverter

Table 3 switching sequence of proposed system

Volt	S1	B1	S2	B2	S3	B3
0	0	1	0	1	0	1
6	0	1	0	1	1	0
12	0	1	1	0	0	1
18	0	1	1	0	1	0
24	1	0	0	1	0	1
30	1	0	0	1	1	0
36	1	0	1	0	0	1
48	1	0	1	0	1	0

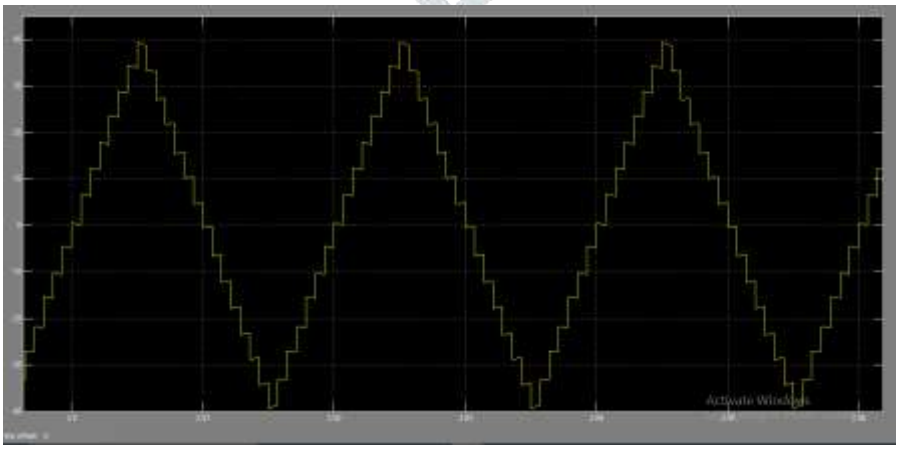

Fig 11 output voltage waveform for 15 level 10 switch multilevel inverter

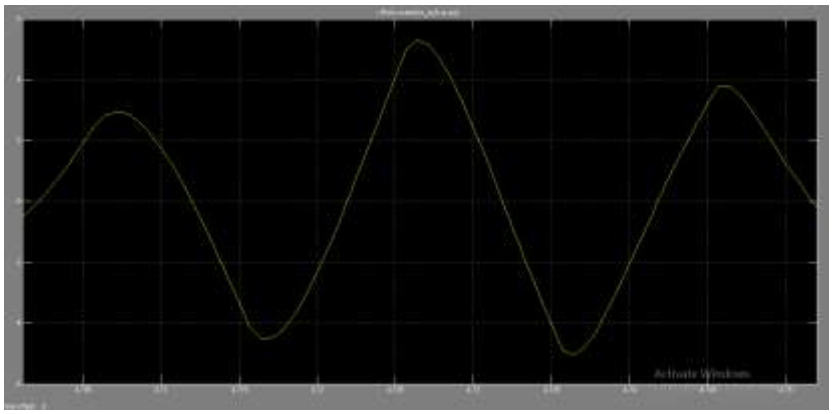

Fig 12: Output current waveform for 10 switch multilevel inverter

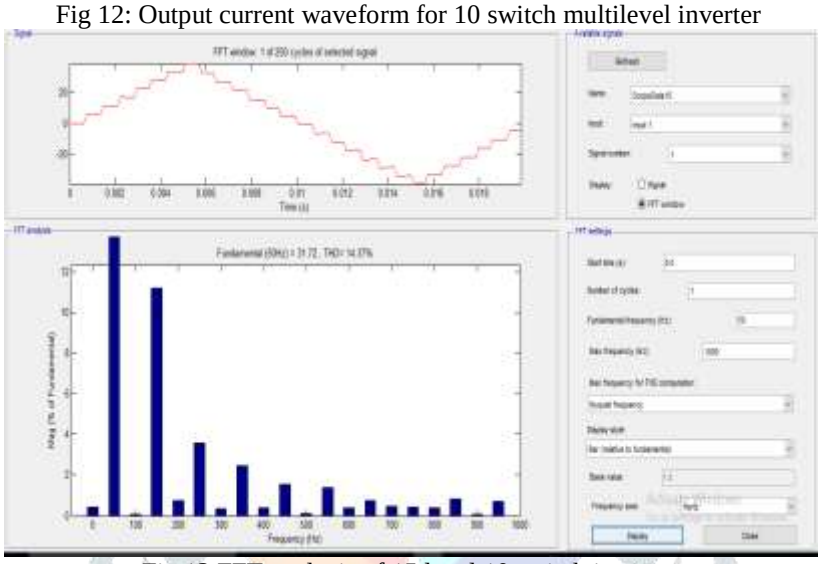

Fig 13 FFT analysis of 15 level 10 switch inverter

Table 4 simulation results for 10 switch multilevel inverter

SR.No	Quantity	Value
1	R.M.S voltage[Vrms]	28.28V
2	R.M.S Current [Irms]	2.9 Amp
3	Maximum voltage[Vmax]	40V
4	Minimum voltage [Vmin]	-40V
5	Peak to Peak Voltage [Vpp]	80V
6	THD	14.37%

V. Conclusion

This paper presented a new MLI topology that can generate 15 levels with reduced components. It can be used in high-voltage high-power applications with unequal dc sources. The proposed scheme reduces number of power switches. As less no of switches used for construction, switching losses and cost for the switches are less. From simulation of 10 switch multilevel inverter and 16 switch inverter , it is clear that, THD for output voltage is less as compared to 16 switch inverter, though the output level waveform is of same levels i.e. 15.RMS output voltage and RMs output current for 10 switch inverter is more than

that of 16 switch inverter. THD for Cascaded H-bridge 16 switch inverter is 15.43% and THD for Switched DC source 10 switch multilevel inverter is 14.37% .The system is applicable in applications like Dynamic Voltage Restorer, Static VAR compensator, active power filters and high-power motor drives.

VI. ACKNOWLEDGMENT

I extend my deep sense of indebtedness and gratitude to my **parents**. I am thankful to my project guide **Mrs.K.S.GADGIL**, for his immense motivation throughout my project and providing me an opportunity to work under his supervision and guidance. His receptiveness to new ideas and his willingness to spare time has always inspired and motivated me. His keen interest, invaluable guidance and immense help were instrumental in the successful completion of this work. I wish to express my heartfelt gratitude to **Mr. S. M. Chaudhari** Head of electrical Engg. Department **Mr. P. P. Mahajan, Mr S. V. Shelar, Mrs. S.S. Landge, Mrs. A. D. Shiralkar** for their constant inspiration and uninterrupted support. I am indebted to the moral support and valuable suggestions provided by them in various stages of this M.E project work. And I am grateful to them for the valuable time they have spared for me during this work..

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[3] International Journal Of Innovative Research In Electrical, Electronics, Instrumentation And Control Engineering Vol. 3, Issue 9, September 2015 Copyright To Ijireeice Doi 10.17148/Ijireeice.2015.3913 63 A Novel Multilevel Inverter With Reduced Dc Sources Ambili R1 , Fareeda A Kareem

[4] Volume 5 Issue VI, June 2017 IC Value: 45.98 ISSN: 2321-9653 International Journal for Research in Applied Science & Engineering Technology (IJRASET) ©IJRASET: All Rights are Reserved 1362 "Novel Multilevel Inverter Topologies for Cascaded Voltage Source Architectures" Subramanian Annamalai1 , Jaisiva Selvaraj

[5] "New Approaches for Harmonics Reduction in Solar Inverters" by Mohammad Ahmad and B. H. Khan, Senior Member, *IEEE*

[6] I Novateur Publications International Journal Of Innovations In Engineering Research And Technology [Ijiert] Issn: 2394-3696 Volume 3, Issue 10, Oct.-2016 18 | P A G E A Multilevel Inverter Based On Switched Dc Sources Bharati S. Mathapati

[7] "Power electronics –devices, circuits and applications" Muhammad.H.Rashid

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Use of FACTS Controller for Relieving Congestion in Power System

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Abstract: ***Congestion in the transmission lines is one of the technical problems that appear particularly in the deregulated environment. There are two types of congestion management methodologies to relieve it. One is non-cost free methods and another is cost-free methods, among them later method relieves the congestion technically whereas the former is related with the economics. In this paper congestion is relieved using cost free methods. Using FACTS devices, congestion can be reduced without disturbing the economic matters. STATCOM and UPFC are two mainly emerging FACTS devices and they are used in this paper to reduce the congestion. Above method is tested on 5-bus system and it can be extended to any practical system. FACTS devices can be an alternative to reduce the flows in heavily loaded lines, resulting in an increased power capability, low system loss, improved stability of the network, by controlling the power flows in the network. Modeling, simulation and analysis of 5 bus system in MATLAB environment is proposed in this paper. Comparison with and without FACTS devices is done to control the power flow and obtain the power system steady state operation. The same system is again analyzed under dynamic conditions and the performance of these devices is observed.***
Keywords: FACTS, UPFC, STATCOM

I. INTRODUCTION

Growth in load demand and the push to change the generation sources to smaller plant utilizing renewable energy sources along with uncertainty of transaction is likely to strain existing power system. This will lead to transmission system functioning closer to their operating limits and caused increased congestion .Therefore ensuring the transmission system is flexible enough to meet new and less predictable power supply and demand condition in competitive electricity market will be a real challenge. In India the power sector was mainly under the government ownership (>95% distribution and ~98% generation) under various states and centaral government utilities, till 1991. The remarkable growth of physical infrastructure was facilitated by four main policies: 1) centralized supply and grid expansion 2) large support from government budgets, 3) development of sector based on indigenous resources.

In mid 1990's Orissa began a process of fundamental restructuring and deregulation of the state power sector. Thereby effective means for congestion management has become an increasingly important issue, especially for deregulated system. New enabling technologies that can maintain the stability and reliability of power system while handling large volume of transmission are able to provide solution .One example of such technology is the Flexible AC Transmission Sysytem .The ability of FACTS controller to support and control power flows in system networks is well known [1-3]. And it is anticipated that the application of FACTS controller will grow in future power system.

The UPFC and STATCOM are the example of second and third generation type of FACTS controller, based on power electronics switches. UPFC has the advantage of controlling both active and reactive power flow simultaneously over STATCOM. The first aspect is the flexible power system operation according to the power flow control capability of FACTS devices. The other aspect is the improvement of transient and steady-state stability of power systems. FACTS devices are the right equipment to meet these challenges [7].

The first aspect is the flexible power system operation according to the power flow control capability of FACTS devices. The other aspect is the improvement of transient and steady-state stability of power systems. FACTS devices are the right equipment to meet these challenges [7].

II. FLEXIBLE AC TRANSMISSION SYSTEM

Flexible AC Transmission System (Facts) is a new integrated concept based on power electronic switching converters and dynamic controllers to enhance the system utilization and power transfer capacity as well as the stability, security, reliability and power quality of AC system interconnections.

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III. UPFC STRUCTURE, OPERATION AND CONTROL

Two main blocks of UPFC are Shunt inverter and series inverter.

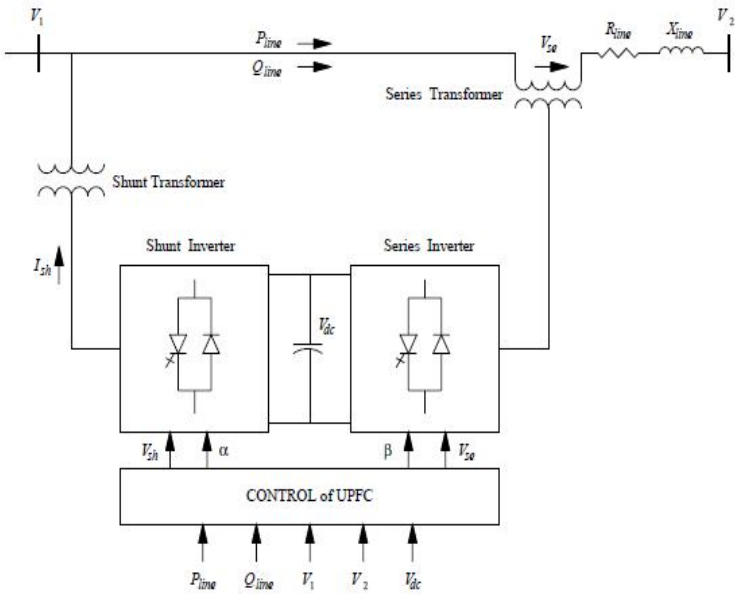

Fig 1: Block diagram of UPFC

A. Shunt Inverter

The shunt inverter is operated in such a way as to draw a controlled current from the line. One component of this current is automatically determined by the requirement to balance the real power of the series inverter. The remaining current component is reactive and can be set to any desired reference level (inductive or capacitive) within the capability of the inverter.[1]

B. Series Inverter

The series inverter controls the magnitude and angle of the voltage injected in series with the line. This voltage injection is always intended to influence the flow of power on the line; its working is similar to that of SSSC.

IV. STATCOM: STRUCTURE, OPERATION AND CONTROL

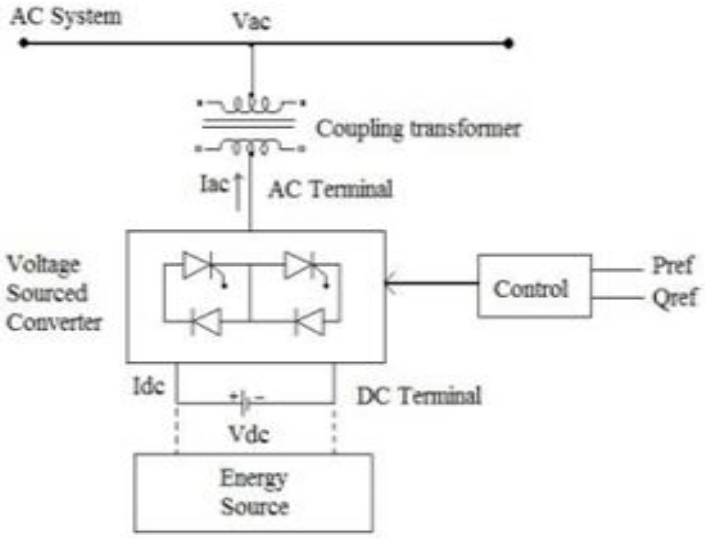

Fig2: Block diagram of STATCOM

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The STATCOM is a shunt connected device. It is connected to the system through a coupling transformer. The control is obtained by the reference values of active (Pref) and reactive power (Qref) . [9, 12]The basic principle for a STATCOM is explained with the help of figure3. The output voltage of the GTO converter (V i) is controlled in phase with the system voltage (V s), as shown in this figure 3, the output current of the STATCOM (I) varies depending on (V i). If Vi is equal to Vs, then no reactive power is delivered to the power system. If Vi > Vs, leading reactive power flows from the STATCOM (Capacitive mode). If V i < Vs, hence lagging reactive power flows into the STATCOM (inductive mode). The amount of reactive power is proportional to the difference between Vs and Vi. This is also the same basic operating principle as a rotating synchronous condenser. Working and V – I characteristics is shown in figure 3[7]. If the system exceeds a low voltage (V1) or high voltage limit (V2), the STATCOM acts as a constant current source by controlling the converter voltage Vi appropriately.

Thus ,when operating at its voltage limits , the amount of reactive power compensation provided by STATCOM is more than most common competing FACTS controllers namely Static Var Compensator (SVC). There by making reactive power controllability of the STATCOM superior to that of SVC, particularly during times of system distress.

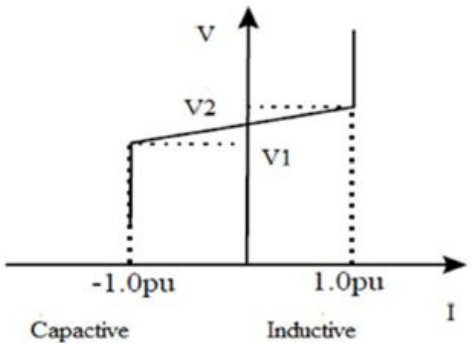

Fig 3: working of STATCOM

V. POWER FLOW MODEL OF UPFC:

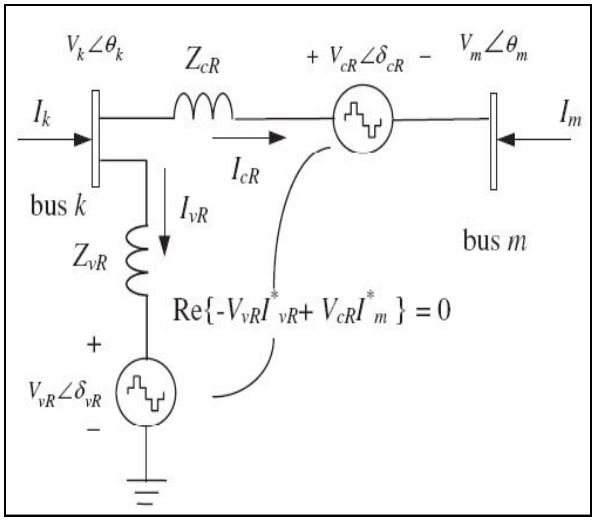

Fig 4: Equivalent circuit of UPFC

The equivalent circuit consists of two coordinated synchronous voltage sources should represent the UPFC adequately for the purpose of fundamental frequency steady state analysis [1]. Such an equivalent circuit is shown in Fig 4.

The UPFC voltage sources are:

$$E_{vR} = V_{vR}(\cos\delta_{vR} + j\sin\delta_{vR}) \quad \text{…..1}$$

$$E_{cR} = V_{cR}(\cos\delta_{cR} + j\sin\delta_{cR}) \quad \text{…….2}$$

whereV_{vR} and δ_{vR} are the controllable magnitude ($V_{vRmin} \leq V_{vR} \leq V_{vRmax}$) and phase angle ($0 \leq \delta_{vR} \leq 2\pi$) of the voltagesource representing the shunt converter. The magnitude $V_{cR}$and phase angle δcR of the voltage source representing the series converter are controlled between limits ($V_{cRmin} \leq V_{cR} \leq V_{cRmax}$) and ($0 \leq \delta_{cR} \leq 2\pi$), respectively. The phase angle ofthe series injected voltage determines the mode of power flow control [1], [4]. If δ_{cR} is in phase with the nodal voltage angle Θk, the UPFC regulates the terminal voltage. If δ_{cR} is in quadrature with Θ_k, it controls active power flow, acting as aphase shifter. If δ_{cR} is in quadrature with line current angle then it controls active power flow, acting as a variable series compensator. At any other value of δ_{cR}, the UPFC operates as a combination of voltage regulator, variable series compensator, and phase shifter. The magnitude of the series injected voltage determines the amount of power flow to be controlled .Based on the equivalent circuit shown in Fig 4 the active and reactive power equations are,

At bus k:

$$P_k = V_k^2 G_{kk} + V_k V_m [G_{km} \cos(\theta_k - \theta_m) + B_{km} \sin(\theta_k - \theta_m)]$$
$$+V_k V_{cR} [G_{km} \cos(\theta_k - \delta_{cR}) + B_{km} \sin(\theta_k - \delta_{cR})]$$
$$+V_k V_{vR} [G_{vR} \cos(\theta_k - \delta_{vR}) + B_{vR} \sin(\theta_k - \delta_{vR})]$$

$$Q_k = -V_k^2 B_{kk} + V_k V_m [G_{km} \sin(\theta_k - \theta_m) - B_{km} \cos(\theta_k - \theta_m)]$$
$$+V_k V_{cR} [G_{km} \sin(\theta_k - \delta_{cR}) - B_{km} \cos(\theta_k - \delta_{cR})]$$
$$+V_k V_{vR} [G_{vR} \sin(\theta_k - \delta_{vR}) - B_{vR} \cos(\theta_k - \delta_{vR})]$$

At bus m:

$$P_m = V_m^2 G_{mm} + V_m V_k [G_{mk} \cos(\theta_m - \theta_k) + B_{mk} \sin(\theta_m - \theta_k)]$$
$$+V_m V_{cR} [G_{mm} \cos(\theta_m - \delta_{cR}) + B_{mm} \sin(\theta_m - \delta_{cR})]$$

$$Q_m = -V_m^2 B_{mm} + V_m V_k [G_{mk} \sin(\theta_m - \theta_k) - B_{mk} \cos(\theta_m - \theta_k)]$$
$$+V_m V_{cR} [G_{mm} \sin(\theta_m - \delta_{cR}) - B_{mm} \cos(\theta_m - \delta_{cR})]$$

A. Equations For Series Converter

$$P_{cR} = V_{cR}^2 G_{mm} + V_{cR} V_k [G_{km} \cos(\delta_{cR} - \theta_k) + B_{km} \sin(\delta_{cR} - \theta_k)]$$
$$+V_{cR} V_m [G_{mm} \cos(\delta_{cR} - \theta_m) + B_{mm} \sin(\delta_{cR} - \theta_m)]$$

$$Q_{cR} = -V_{cR}^2 B_{mm} + V_{cR} V_k [G_{km} \sin(\delta_{cR} - \theta_k) - B_{km} \cos(\delta_{cR} - \theta_k)]$$
$$+V_{cR} V_m [G_{mm} \sin(\delta_{cR} - \theta_m) - B_{mm} \cos(\delta_{cR} - \theta_m)]$$

B. Equations For Shunt Converter

$$P_{vR} = -V_{vR}^2 G_{vR} + V_{vR} V_k [G_{vR} \cos(\delta_{vR} - \theta_k) + B_{vR} \sin(\delta_{vR} - \theta_k)]$$

$$Q_{vR} = V_{vR}^2 B_{vR} + V_{vR} V_k [G_{vR} \sin(\delta_{vR} - \theta_k) - B_{vR} \cos(\delta_{vR} - \theta_k)]$$

Assuming lossless converter values, the active power supplied to the shunt converter, P_{vR}, equals the active power demanded by the series converter, P_{cR}; i.e. $P_{vr+} P_{cr} = 0$. Furthermore, if the coupling transformers are assumed to contain no resistance then the active power at bus k matches the active power at bus m. Accordingly, . $P_{vr} + P_{cr} = Pk + Pm = 0$. The UPFC power equations are combined with those of the AC network.

VI. POWER FLOW MODEL OF STATCOM

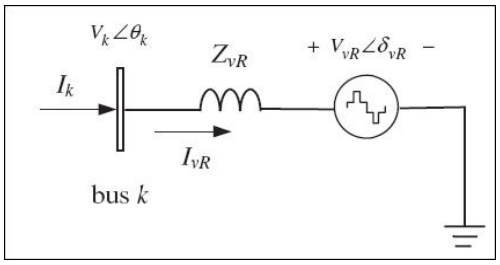

Fig 5:Equivalent circuit of STATCOM

The Static synchronous compensator (STATCOM) is represented by a synchronous voltage source with minimum and maximum voltage magnitude limits [12]. The bus at which STATCOM is connected is represented as a PV bus, which may change to a PQ bus in the events of limits being violated. In such case, the generated or absorbed reactive power would correspond to the violated limit. The power flow equations for the STATCOM are derived below from the first principles and assuming the following voltage source representation [2].

$$E_{vR} = V_{vR}(\cos\delta_{vR} + j\sin\delta_{vR})$$

$$S_{vR} = V_{vR}I_{vR}^{*} = V_{vR}Y_{vR}^{*}(V_{vR}^{*} - V_{k}^{*})$$

The following are the active and reactive power equations for the converter at bus k,

$$P_{vR} = V_{vR}^{2}G_{vR} + V_{vR}V_{k}[G_{vR}\cos(\delta_{vR} - \theta_{k}) + B_{vR}\sin(\delta_{vR} - \theta_{k})]$$

$$Q_{vR} = -V_{vR}^{2}B_{vR} + V_{vR}V_{k}[G_{vR}\sin(\delta_{vR} - \theta_{k}) - B_{vR}\cos(\delta_{vR} - \theta_{k})]$$

And,

$$P_{k} = V_{k}^{2}G_{vR} + V_{k}V_{vR}[G_{vR}\cos(\theta_{k} - \delta_{vR}) + B_{vR}\sin(\theta_{k} - \delta_{vR})]$$

$$Q_{k} = -V_{k}^{2}B_{vR} + V_{k}V_{vR}[G_{vR}\sin(\theta_{k} - \delta_{vR}) - B_{vR}\cos(\theta_{k} - \delta_{vR})]$$

Based on the power flow models given above for STATCOM and UPFC the analysis simulation and modeling of the system is done.

VII. STATIC ANALYSIS OF THE SYSTEM

The objectives of this Paper are to:

1) Simulate 5 bus power system network using MATLAB software .
2) Model UPFC and STATCOM in5 bus power system network and determine the power flow .
3) Perform the steady-state analysis of the 5 bus power system network before and after UPFC and STATCOM are applied.

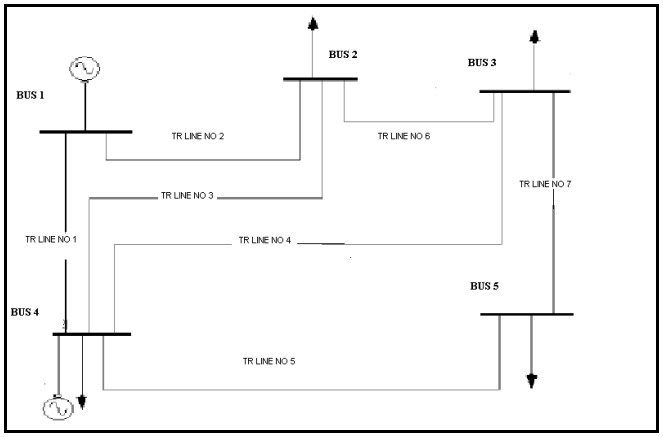

Table 1: Bus results with and without FACTS devices

BUS NO.	Without FACTS DEVICES(pu)	WITH STATCOM	WITH UPFC
1	1.06	1.06	1.06
2	0.9871	1.013	0.9998
3	0.9836	0.9946	0.9901
4	1.01	1.002	1.0037
5	0.9721	0.9753	0.9746

Table 2: Line result without FACTS devices

LINE NO	P (p.u)	Q(p.u)
01	0.1340	1.2118
02	0.1522	0.2122
03	-2.2139	0.5220
04	-2.1820	0.3555
05	-6.2785	2.9302
06	-22.9455	10.9021
07	-3.5902	5.5066

The simulation yields the power flow for lines and bus active and reactive powers which are tabulated above .From the power flow results for the 5-bus system, it can be observed that the voltage magnitudes at bus 2, bus 3 and bus 5 are lower than 1.0 p.u.So , these are the potential buses where FACTS devices can be included .The active power in line 6 is 22.9455 p.u and the reactive power is 10.9021 p.u .

Table 3: Line result with STATCOM at bus 2

LINE NO	P (p.u)	Q(p.u)
01	1.4068	0.8461
02	0.1492	0.2457
03	5.3052	5.6402
04	5.3496	5.3818
05	7.8564	7.2254
06	30.6750	30.9922
07	-3.6099	5.3440

It is very clear from the comparison of table 2 and table 3,that the nodal voltage is maintained at 1.013 at bus 2 by STATCOM and the phase angle is also improved to -4.7529(degrees) from 0.464(degrees) . The active power is also increased from 22.9455 (p.u) to 30.6750 (p.u)

The installation of the STATCOM resulted in improved network voltage profile (Table 4.3).The slack generator reduces its reactive power generation by 5.9% compared with the base case .The reactive power absorbed by the bus 4 generator increased by 25% of the base case. In general, more reactive power is available in the network when compared with the base case due to the installation of STATCOM.

Table 4: Line result with UPFC at bus 2

Line no.	P	Q
01	0.2719	1.0112
02	0.3028	0.2468
03	-4.0745	2.0098
04	-4.0005	1.8088
05	-7.5400	9.9569
06	-30.1488	35.7096
07	2.7342	6.7163

UPFC increases the amount of reactive power supplied at the bus 2 to 35.7096 (p.u) which very high as compared to 30.9922 (p.u) with STATCOM and10.9021 (p.u) without any FACTS devices. There is increase in the active power also due to the demand of the UPFC series converter.

VIII. DYNAMIC ANALYSIS OF THE SYSTEM

In this analysis load is taken as the time varying entity .Simulation results (graphical) are as shown below.

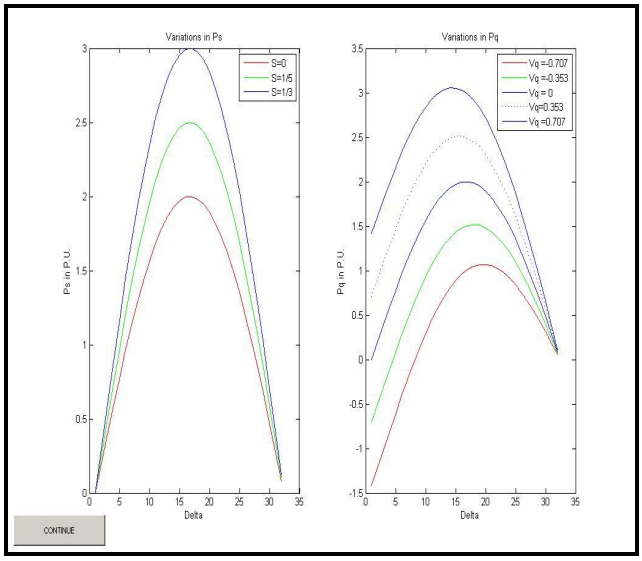

Fig 6: active power and reactive power variations with respect to phase angle δ.

Figure3 explains the importance of reactive power compensation at a load bus if there are no generators in the vicinity to regulate the bus voltage. The reactance factor (S = Xc/Xl) determines the nature of the active power curve. The higher the value of reactance factor the more is the value of active power. The various values of load bus voltages are shown in the figure and how this varies the reactive power along with the phase angle δ. Power reaches its maximum when Vq = 0.707. But instead of the FACTS devices if fixed capacitors are used for compensation then even if Vq is increased to 1.0 there is no change in the value of power which is not the case with SSC or UPFC. The Y- axis shows the Ps and Pq respectively inp.u and the X – axis shows the phase angle δ.

A. Power Flow Graphs With Statcom

The five bus system is dynamically analyzed with STATCOM at bus 2. Figure 4, below shows three results:

1) Voltage and current graphs
2) Phase distortion and current variations
3) Reactive power injected and phase injected.

The Y- axis shows the grespective parameters in p.u and the X - axis shows the time (in ms). Each result is further subdivided into three section, the first section (t=0 to t =480 ms) represents the system when the FACTS devices are not operating, the second section (t=500 to t=1000 ms) shows the active power compensation with STATCOM included and the third section (t=1000 to t= 1400ms) explains the reactive power compensation provided by the device in the system.

It can be clearly seen from the results obtained in figure 5.2 that the STATCOM provides far better compensation in terms of voltage , reactive power injected , current as compared to the base case when there are no devices in the system. The phase distortion is also reduced considerably .The STATCOM helps in maintaining the magnitude of current nearly the same in both the cases that is active as well as reactive power compensation

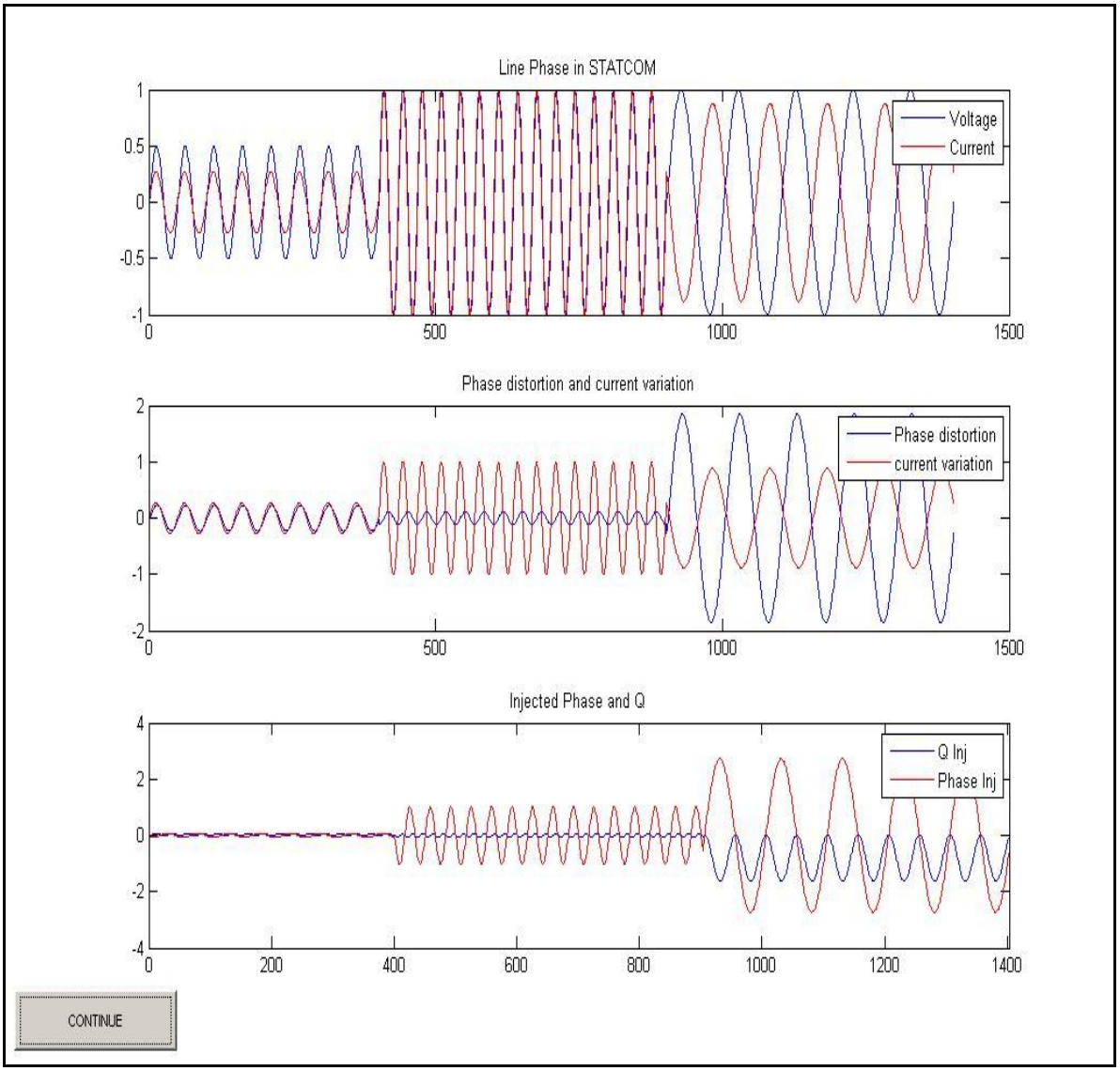

Fig 7: Graph showing the results of STATCOM inserted at bus 2

B. Power Flow Graphs With Upfc

The UPFC is included in bus 2 and bus 3.

Comparison of Figure 7 and 8 show that the system response with UPFC in the system is comparatively better that not only the base case but also the STATCOM results . The phase distortion has nearly become linear . This shows that UPFC can control not only voltage, impedance but also phase angle. All the three parameters are controlled by the UPFC and hence the name UNIFIED Power Flow Controller.

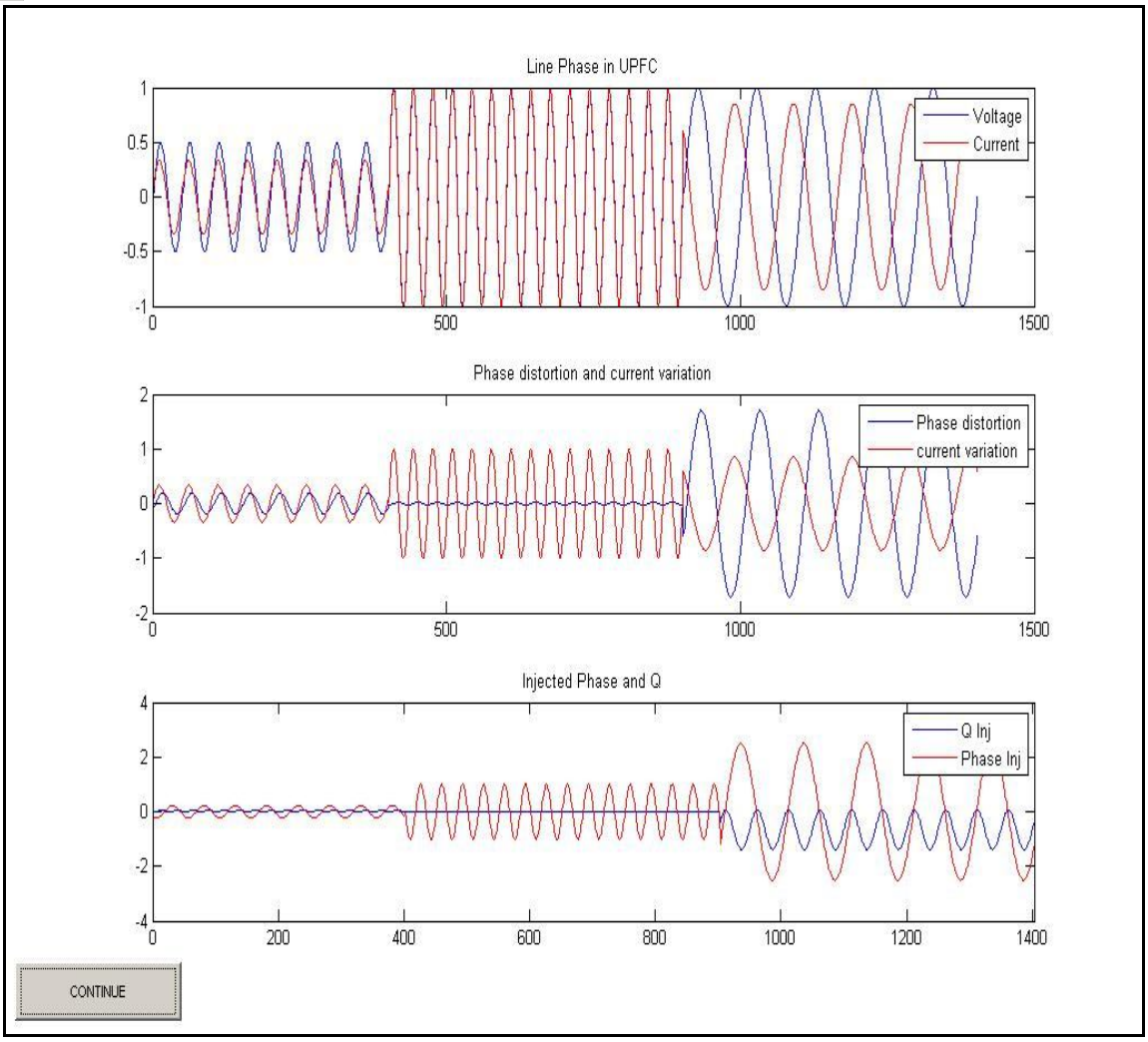

Fig 8: Graph showing the results of UPFC inserted at bus3 and 4

IX. CONCLUSION

This paper has proposed cost free congestion management methods required for smooth operation of deregulated power system. It gives the remedy for congestion by enhancing active power flow capability of transmission line. Simulation methods required for study of the steady state as well as dynamic operation of electrical systems with FACTS devices UPFC and STATCOM is analyzed in the paper. The power flow for the five bus system was analysed with and without FACTS devices. The power flow indicates that there is nearly 5.9 % increase in the reactive power absorption compared with the base case when STATCOM is included in bus 2. The largest reactive power flow takes place in the transmission line connecting bus 2 to bus 3, which is 30.9922 p.u. The direction of reactive power flow remains unchanged.

The sample 5 bus network is modified to include one UPFC to compensate the transmission line no. 6 linking bus 2 and bus 3. The UPFC shunt controller is set to regulate the nodal voltage magnitude at bus 2 at 1 p.u. There is large amount of increase in the active power as well as the reactive power. The steady state models of STATCOM and UPFC are analyzed and evaluated in Newton-Raphson algorithm.

Both, the static and the dynamic analysis show that UPFC is able to control not only the voltage but also the impedance and phase angle which affect the power flow in the transmission line. Same is true for the fourteen bus system also .Convergence is obtained in four iterations to a power mismatch tolerance of 10^{-12}. There is increase in the active power also due to the demand of the UPFC series converter. The negative sign shows the direction of power flow from the shunt converter end to the series converter end.

The STATCOM was able to effectively regulate the bus voltage magnitude at which it was connected but UPFC has proven to be far more better than the STATCOM for the system being analyzed .

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BIOGRAPHIES

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Earth Leakage Protection of Various Equipment using Arduino

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Abstract: ***An earth fault protection of various equipment using Arduino is proposed in this paper, Construction of this circuit is done on the basis of ground fault circuit interrupter. The circuit trip on the tiniest difference in the current of the supply and return path. The leakage is detected by this difference which may damage a device and human operator. Both hardware and software are introduced in this circuit.***
Index Terms - 3 winding transformer, Arduino, relay, leakage current, fault protection.

I. INTRODUCTION

Nowadays, the leakage protection is very important technology in the various low-power rating field, this leakage current may damage the equipment also get hazardous for human being from electrical shock so, in protection of various electrical equipment we are going to construct circuit on the basis of ground fault circuit interrupter. Whenever any fault occurred in the equipment ground fault circuit interrupter (GFCI) is going to disconnect the circuit. whenever it detects the leakage current, that Causes electric current Unbalance between the energized conductor and the return neutral conductor. This unbalance indicates current leakage through the unwanted path of the circuit, which is grounded and accidentally touching the energized part of the circuit may get hazardous shock. So, to protect specific equipment's it is necessary to switch off the supply. In view of above situation this paper provides information about the protection from earth leakage current by designing protection circuit based on Arduino programming kit which helps us to give specific threshold value for the specific equipment's so that when any fault occurs and this cross the threshold value then Arduino going to trip that equipment only and other equipment's are safe for operation.

II. OBJECTIVES

A device is design to detect the leakage current in the circuit, the leakage current is given to op-amp to get the voltage waveform and by adjusting the gain we can adjust the value. and then further we give output of op-amp to rectifier which are used to get dc for Arduino programming. By designing the protection device with the help of the Arduino we can achieve so many benefits as well as the flexible operation for various power ratting equipment. Where we are designing this device so that we can achieve following objective. To protect the various equipment.

III. METHODOLOGY

Methodology is the process to find the suitable project, make the researching and study all of the project information, choose the suitable method for design this project, planning the time and selecting the equipment such as material is needed and computer software program. After selection of the topic it is very essential to separate the whole work in different phases so to make work suitable and more efficient, we divide the work in four different phases.

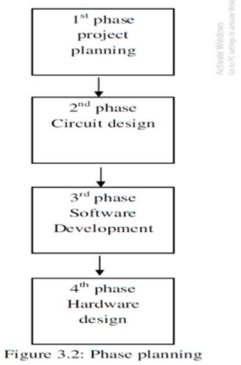

Figure 3.2: Phase planning

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IV. PROJECT PLANNING

To Develop any project the main thing requires which is to collect information. In the 1st phase the all the information regarding the hardware and software is collected by reading various papers and doing literature survey, in which the selection of proper method for earth leakage current sensing device is decided then to perform the various experiment to collect the required ranges and set a proper sensing method for that equipment and the material require for designing, there ranges to sustain that leakage current also in software which type of software is going to use, there ranges all these information is collected in the project planning.

V. HARDWARE DESIGN

The main part in this project is to build the hardware, to detect the earth leakage current. The detection of earth leakage current is main problem. With the help of the literature survey and performing various experiment for the earth leakage protection device the final conclusion is to go for 3 winding transformers to detect the earth leakage current.

A. Construction

In 3 winding transformers, 3 windings are placed on transformer core where the primary and secondary windings are having same number of turns also have same current rating but they placed are opposite to each other such that their flux cancel each other. Here the tertiary winding (tripping winding) having a large number of turns than primary and secondary where their turns ratio is 1:1:10. The test button is used to test the equipment is working or not.

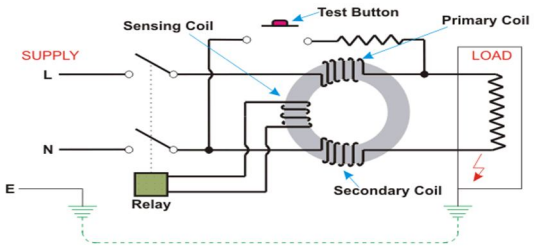

Fig. 3 Basic circuit diagram

B. Working

As show in Fig. 3 winding are placed on transformer core. In normal condition the same current pass through primary winding, and return back through secondary winding. Both primary and secondary winding are placed in such a way that the magnetic flux produced is in opposite direction so in healthy condition the same current pass through both winding so this will cancel each other's magnetic flux. In faulty condition the leakage pass to anywhere in circuit so the current returning through secondary winding is reduced. So, the magnetic flux present inside the transformer core is not equal anymore. So, the periodically changing magnetic flux inside the transformer core cut the tertiary winding conductors, this action will induce the electromotive force(emf) across the tertiary winding. Where it is an alternating in nature. The induced voltage across the tertiary winding produces a current in the (trip circuit). This current is sensed by the relay (Arduino) and it will give the command to the C.B. to operate.

C. Winding Transformer Design

In 3 winding CT we have to convert the current into the voltage because voltage is sensed by the Arduino easily. For this conversion we have to put a resistor. This resistor causes the burden on the CT. The main reason to go for 3 winding transformers instead of current transformer (CT) is because of problems arrive due to burden on CT. During the Fault condition the unbalance current derive is very small so due to burden this value get negligible. Due to this in the tertiary winding it fails to maintain CT ratio so it is better to design 3 winding transformers rather than current transformer (CT).

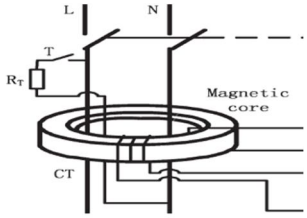

Fig. 3 Winding Transformer

To design the 3 winding Transformer, the turns ratio for primary and secondary winding are kept to be equal which is 40 turns and 2 amp. current rating is to be calculated by practical performance and tertiary winding has 400 number of turns are calculated through practical performance where 3 tapping are to be given to tertiary for identification of magnitude of fault current. This three tapping are given at 120, 280, 400 number of turns. Where current ranging for tertiary winding has 50-100 m amp. These are on the basis of 1:10 turns ratio which can be calculated as above.

VI. SOFTWARE DESIGN

After hardware designing, we step forward toward the software designing. In this we are going to use Arduino for giving command to the circuit for protection. And protection is as per the threshold value given for operation to the Arduino. whereas Arduino is an open source hardware & software device. Arduino consist of variety of microprocessor and controller. The Arduino board consist of set of digital and analog input and output (i/o). Arduino has many benefits such as easy programming, flexible operation and inexpensive. the main task of circuit is to detect the leakage current and calculate the valid value, calculating variation in leakage current, judging and processing for the protection

The software system mainly consists of main program, data processing sub program, and leakage protection program. the main program will be carried as top-down infinite loop, the interruption in system will respond according to as per priority as given by software as interruption occur it will return to the main program and continue the execution after being completed.

A. Main Programming Design

The main function of main program to conduct the program flow & connecting each sub program. the main program provide initialization, data processing, failure treatment and interrupt handling and also timer & commutation interruption.

B. Data Processing Sub Program Design

The timing detection of current and digital filter is realized by data processing. the adjustment of the threshold value by adaptive adjusting is done by calculating the average value of data as per the tripping circuit. the variation of the leakage current should be greater than that of threshold leakage value set as per circuit. And the time duration must be greater than the set relay time.

C. Earth Leakage Protection Sub Program Design

The leakage current protection is detected by the circuit accordingly to compare between the leakage current value and setting value, the delay time as per provided in the circuit and also as per given by user. The value of leakage variation is less than rated value then the action would be normally operated. if the time duration is more than action should be relatively adjusted.

VII. TESTING

Testing phase are divided into two level first level is unit step, where the system is tested part by part and error is to be measured. Second level is integration test where the complete combine system between hardware and software part is examined. As per practical performance the error occurred are eliminated through changing the Arduino programming. The timer is to be set as if small fault come then the circuit is trip for only small period of time. And after this time the circuit again come in on condition.

VIII. PROBLEM STATEMENT

When the earth fault occurs and someone barely touched it they may get hazardous shock. so, there we use elcb (earth leakage circuit breaker) but this device trip all the system so if sometimes some small fault occur and this breaker sense this fault and trip all compartment. it requires time to erase this fault and due to such small fault, we could not use our other equipment and in industries it gets huge loss. So, we are going to develop an equipment which can trip only faulty part and others equipment remains healthy.

We are going to develop this equipment by using Arduino which is used to give separately command to circuit breaker to trip only faulty equipment and secure the other part also secure from fault occurring to all other compartment.

IX. ADVANTAGES

EARTH leakage circuit breaker has one major advantage over RCDs that they are less sensitive to fault conditions, and therefore have fewer nuisance trips. There is situation in which an ELCB can nuisance trip because the voltage and current on the earth line is usually fault current from live wire. While voltage and current on the earth line is usually fault current from a live wire, this is not always the case.

As the high current lightning strike would cause a voltage gradient in the soil, presenting the earth leakage circuit breaker sense coil with enough voltage to cause it trip this is only because of an installation has two connections to earth.
Also, this device is cost efficient device which has minimum the required cost as compare to other equipment's.
This equipment can also be used in AC as well as DC. but for DC we have to modify the transformer design as per the requirement.
By using Arduino, we can use this devise for wide range for equipment in which we only have to change the programming as per the equipment.
And this devise can also be used for commercial as well as industrial purpose, only due use of Arduino we can modify programming as per our requirement.

X. DISADVANTAGES

They do not detect faults that don't pass current through the CPC to the earth rods. They do not allow a single building system to be easily split into multiple sections with independent fault protection, because earthing systems are usually use common earth Rod.
We can assume that the earth leakage fault protection device is the ***brain for the shock protection***, and the grounding as the backbone. Therefore, without a functional grounding (Proper Earthing of Electrical System) there is totally no protection against electrical shocks in your house even if You have installed ELCB and its TEST switch show proper result. Looking after the ELCB alone is not enough. The electrical Earthing system must also be in good working order for the shock protection system to work. The qualified electrician had done the routine inspection, to check the grounding system should be inspected regularly at shorter intervals by homeowner and need to pour water in Earthing Pit to minimize the earth resistance at regular basis.
This brings us or alarming us to think over second basic requirement for earth protection. The second requirement for the proper operation of a home shock protection system is electrical grounding.

XI. CONCLUSION

The main focus of the project is to develop the device in cost efficient way. the device is use for safety of industries, residential & commercial etc. one single device will give wide range of control over equipment. As device is programmable, new firmware will unleash new intelligence and advance feature in the device. Protection and control of equipment play very important role in today's era. where protection is provided to eliminate the leakage in the system. so, we are using Arduino programming for various benefits.

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Design Implementation and Analysis of Energy Efficient Illumination Scheme for AISSMS IOIT, Pune

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***Abstract*— Lighting load is a major component of electrical load in an educational institute. Almost 20% of load is lighting load thus it is the major area of concern related to energy conservation. An attempt is made in this project to analyze the existing lighting illumination scheme of particular sections in an educational institute. Illumination level is quantified using standard measurement technique. The light pack software is used for detailed analysis. The calculations as per conventional method related to illumination scheme design are also included. Revised illumination scheme is proposed taking into consideration the energy conservation and energy efficiency. The revised illumination scheme provides improvement in quality of illumination and energy efficiency. The payback calculations are also included to justify the economics of revised illumination scheme.**

Keywords*— Illumination, power quality, power consumption, LITE PACK, LUX meter.

I. INTRODUCTION

The illumination should provide favorable visual performance, visual comfort, ease of seeing and safety. Most of the academic activity involves good visual performance which can be achieved with proper illumination. Educational institute comprise of different occupancies like classroom, library, laboratory, corridor, washrooms, multipurpose hall, administrative office.

Since lot of work requires clear visibility illumination is an important aspect. Average illumination as per standard is as follows;

Table no. 1

Sr no.	Occupancies	Standard average illumination (LUX)
1.	Classroom	250
2.	Library	300
3.	Laboratory	300
4.	Multipurpose hall	500
5.	Administrative office	500
6.	Corridor	100
7.	Washroom	100

The quality of existing illumination scheme is studied by standard measurement, calculation and by the use of software. Revised illumination scheme is proposed which gives better quality of education and better energy efficiency. All the measurements are carried out by using LUX meter Measuring range : 0-50000 lux .

A sample of payback period calculation for respective luminaries is also presented.

But modern luminaries like CFL's and LED's produce harmonics as electronic circuits are used for their ignition. Due to use of power electronic circuitry the load becomes nonlinear, which in turn impacts on the power quality of consumer side low voltage grids and ultimately on utility and generation sides .The concern for the quality of power is increasing amongst both electric utilities as well as end users of electric power. Hence maintaining proper illumination without compromising the power quality is the main focus of this project.

II. OBJECTIVES

These are the objectives which are obtained by project analysis:

1. To study the existing lighting scheme of the institute.
2. To analyze the existing system by carrying out various steps.
3. To work out the replacement of fluorescent bulbs with the LEDs for improving illumination and attain maximum efficiency and to maintain power quality.
4. To carry out payback period calculations and suggest the most economical combination of luminaries.

III. METHODOLOGY

Indian standard was adopted by the Indian Standards Institutions on 19 march 1984.This standard has been prepared to deal with the special aspect of lighting for educational institutes and shall be read in conjunction with

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IS :3646(PART I)-1966*, IS : 3646(PART II)-1966* and IS :3646(PART III)-1968*

This standard covers the principles and the practices governing good lighting in educational institutes and stresses on the importance of good visual environment for education. It also recommends the level of illumination and quality requirements to be achieved by general principles of lighting.

a) EQUIPMENTS REQUIRED

For the analysis purpose the following instruments-

Table no. 2

LUX meter	It is an analog or digital electronic device that measures the illumination level of the area.
LITE pack software	It is a tool for visually designing. Havel's LITE pack version 3.00. The parameters are entered in the software and the illumination distribution is obtained.

b) COLLECTION OF DATA

The area of respective occupancies is measured .The illumination at different points in respective areas is measured and average illumination is calculated.

c) OBTAINING AVERAGE LUMENS BY USE OF LITE PACK:

The existing illumination scheme performance is analyzed using LITE PACK software. Different parameters and physical dimensions are given as input to carry out the analysis. The report generated through this software contains-3D ISO LUX diagram, Gray scale pattern, Light distribution, Illumination distribution in tabular form giving maximum ,minimum, average values along with the different ratios of these quantities.

d) COMPARING THE DATA FOUND OUT BY MANUAL METHOD AND SOFTWARE

The data obtained from the manual interpretation and software is compared and the accordingly the suggestions are provided.

e) SUGGESTIONS

Suggesting replacement of fluorescent bulbs with LEDs for maximum efficiency and maximum power output. Table no. 3

IV. ANALYSIS OF EXISTING ILLUMINATION SCHEME

Table no. 3

LOCATION	EXISTING AVERAGE ILLUMINATION LEVEL (Measured by Lux-meter)	AVERAGE ILUMINATION LEVEL AS PER LITE PACK SOFTWARE	Illumination required as per the Indian Standards	REMARK
108-B Meeting Room	55.9	58.8	250	Not sufficient
010-A Physics Laboratory	154.57	105	300	Not sufficient
010-B Mechanical Laboratory	61.62	105	300	Not sufficient
010-C Civil Laboratory	91.6	55	300	Not sufficient

V. POINT-BY-POINT LAYOUT- 3D LUX WEB

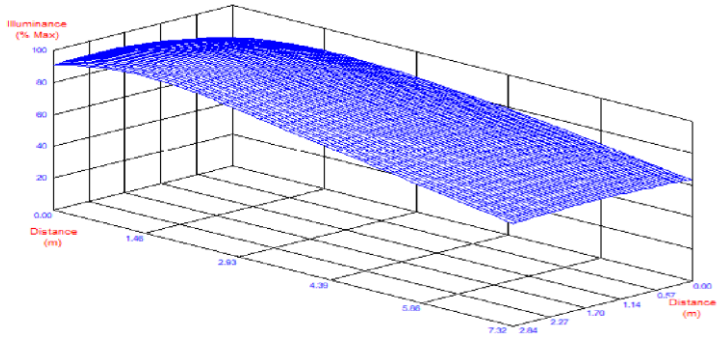

Fig.1. Room No. 108 B

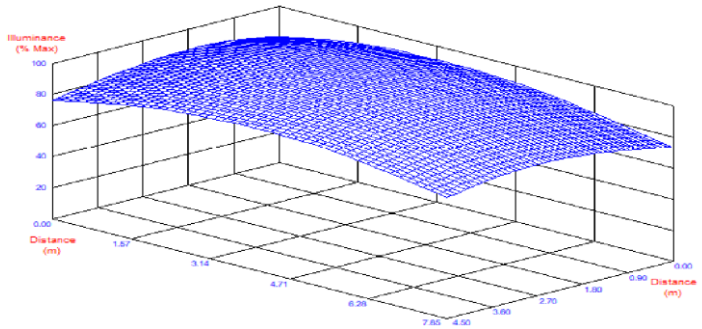

Fig.2. Room No.010. A

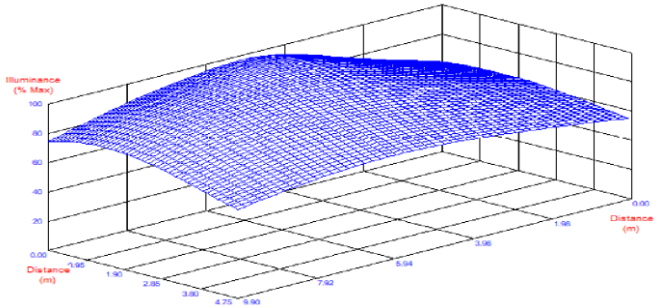

Fig.3. Room No. 010 B

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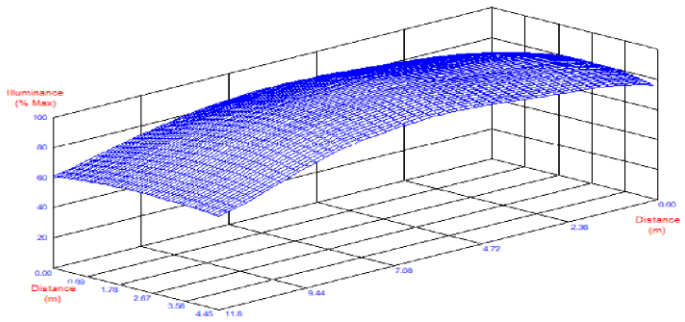

Fig.4. Room No. 010 C

VI. PAYBACK PERIOD CALCULATIONS

Payback period is the time taken by a business investment to recover its initial outlay in terms of profits or savings.

Payback period=Initial investment/annual payback.
Example.

For Room No. 108 (B)-

(a) Determination of the type, number and operational schedule of the lamps currently installed.
This will require a room inspection, in order to determine the characteristic of current installation. Following results are obtained:
Lamp type – 40 watt, T12 fluorescent, 4ft 1200mm
No. of lamps -12, Total Lumen output= 2300Lumes
Operation schedule – 7 hrs.

(b) Estimate demand in kilowatt and energy consumption in kWh:
The demand and consumption can be calculated by
Demand (kW) = [no. of lamps x power per lamp (w)]/1000
= [12x40/1000]
= 0.48kW
Energy kWh = [Demand (kW) x operational hours]
= [0.48x 7]/30
= 0.112kWh

(c) Estimate demand and consumption with the energy efficient alternative and compare
Consider a LED alternative is available which replaces the current lamps:
Type of LED – 16 watt, T8 equivalent LED Tube, Total Lumen output= 2300 Lumens
No. of equivalent LED – 12
Demand (kW) = [12x16]/1000
= 0.192
Energy (kWh) = [Demand (kWh) x operational hours]
= [0.192 x 7]/30
= 0.0448
Comparison:
Demand reduction = 0.48Kw - 0.192kW
= 0.288
Consumption reduction = 0.112 kWh/mo - 0.448 kWh/mo
= 0.336 kWh/mo

MSEDCL Charges=14.8 Rs/kWh
Total saving
= 14.8x0.336 Rs /mo
=4.972 Rs /mo.
Additional investment in LED
= (LED bulb cost) - (Fluorescent bulb cost)
= (200-50) Rs
=150Rs
Payback Period
=Additional investment / total saving
=150/4.972 Months
=30.168 Months
=2.51 Years.

In this scenario energy need of the lighting system is reduced by 40%, however this only considers direct energy savings from the lighting upgrade and it has a payback period of 2.51 years.

On the similar basis the calculation is carried out for the remaining occupancies.
The saving is 4.972Rs per month.
The payback period is 2.51 years.

Summarization of savings per month and payback period:

Table no.4

Sr.no	Room No.	No. of lights	kWh (fluorescent)	kWh (LED)	Total saving (Rs/mo)	Payback period (Years)
1.	108 B	12	0.112	0.0448	4.972	2.51
2.	10 A	8	0.074	0.029	0.666	1.8
3.	10 B	20	0.186	0.074	1.657	3.4
4.	10 C	6	0.056	0.0224	0.497	2.09

The average of the payback period is 2.45 years.

IV CONCLUSION

- We can conclude that the existing illumination system is not enough to provide an optimum visual environment for both students as well as faculties.
- In addition to the data mentioned in –IV and in table no. 4, the analysis of other occupancies is also carried out on similar basis. The existing and expected average illumination for these occupancies is summarized in following table:

Table no. 5

Sr no.	Occupancies	Existing average illumination (lumens)	Required average illumination (lumens)
1.	Classroom	170	250
2.	Library	250	300
3.	Laboratory	150	300
4.	Multipurpose hall	250	500
5.	Administrative office	300	500
6.	Corridor	70	100
12	Washroom	50	100

- It can be seen from the above table that the average illumination of the existing system is not sufficient and changes in luminaries is to be done.

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- Replacement of fluorescent bulb with the CFLs for maximum efficiency and to meet the required average illumination.
- After replacement the payback period is of 2.45 years, which means it will require 2.45 years to recover the initial expenses that were required to install all the LEDs. The life of LED luminaire is about 6 years.

ACKNOWLEDGMENT

This paper on “design implementation and analysis of energy efficient illumination scheme for educational institute” is outcome of guidance, moral support and devotion bestowed on us throughout our work. For this we acknowledge on profound sense of gratitude and thank everyone who has inspired us throughout the preparation of this paper.

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Power Quality Audit and Compliance As Per IEEE519-2014 Steering Manufacturing Industry (India)

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***Abstract*: This paper presents the power quality audit of electrical installations and their loads for Steering Manufacturing Industry. Large inductive loads such as furnace, various manufacturing machines and short blasting machines etc., cause increase in losses, increase in neutral current, maloperation of sensitive electronic equipment's etc. Some of the major power quality issues are voltage sag, harmonics, poor power factor, unbalancing etc. Fluke 435-II power quality analyzer is used to conduct the power quality audit. Measurements were takenwith and without APFC.**

Keywords:Power Quality, Harmonic, Energy losses, Power Analyzer, THD

INTRODUCTION

Power quality is the important factor because most of power related problems that occurs in voltage, current, or frequency deviationsresult in failure of customer devices. Differentpower quality related problems are: frequency deviations, powersystemharmonics (in voltage, current, power and energy etc.),distortion of harmonics, transients in power system, poor power factor, etc. Power frequency deviations are low-frequencyphenomenonthat results in voltage sags or swells. These may besource or load generated caused due to faults or switching operations. Some of the major power quality issues are voltage sag, harmonics, poor powerfactor, unbalancing etc. Harmonics are integer multiple offundamental frequency. The frequency of each harmoniccomponent is called as harmonic frequency.The Power Quality Audit is an effective tool to reduce energy losses, helps in preventive maintenance and gives us quality control methods.The main objective of Energy Auditis to determine ways to reduce energy consumptionper unit of product output and/or to lower operating costs.Energy Audit provides a "benchmark" for managing energy in the companyandalso provides the basis for planning more efficient use of energy throughout the company. In this company there are three transformers and one solar panel. Fluke 435-II Power analyser is used for measuring power quality compliances.

TECHNICAL DETAILS OF ELECTRICAL INSTALLATIONS

Transformer1

Make-Crompton Greaves; 2000kVA, 3 Phase, Δ/Y Frequency-50 Hz, Type of cooling- ONAN, Line Current HV-52.5 A, Line current LV-2667 A, No load voltage ratio-22/0.433 kV, No. of taps-8, Percentage impedance-6.48%, Vector group-DY,n11, No OLTC.

Transformer 2

Make-CromptonGreaves; 2000kVA, 3 Phase, Δ/Y Frequency-50 Hz, Type of cooling- ONAN, Line Current HV-52.5 A, Line current LV-2667 A, No load voltage ratio-22/0.433 kV, No. of taps-9 , Percentage impedance-6.48%, Vector group-DY,n11, With OLTC

Solar Grid

Make- Kalpa Power; DC side- 487.05 kWp, AC Side- 450 kW, Solar inverter-14 AC Side- 50kW, DC Side-61.75kWp

FLUKE 435-II POWER ANALYZER

Figure 1 Fluke 435-II power analyzer

Fig.1 shows Fluke 435-II power analyzer with current and voltage probes.

Features of Fluke 435-II power analyzer are as follows:

Logger- used to store multiple readings with extreme resolution in a long memory.

Phase voltages- Should be close to the nominal value. Voltage waveforms must be a sine wave and free from distortion. Use Scope Waveform to check the waveform shape.Use Transients mode to capture voltage anomalies. Use Dips & Swells to record sudden voltage changes.

Crest Factor- A CF of 1.41 or higher means high waveform distortion. Use Scope Waveform to check waveform distortion. Use Harmonics mode to check harmonics and THD (Total Harmonic Distortion).

Harmonics-Use Harmonics mode to check for voltage and current harmonics and THD per phase. Dips & Swells- Use Dips & Swells to record sudden voltage changes as short as half a cycle.

Phase currents-Use Volts/Amps/Hertz and Dips and Swells to check current/voltage relations.

Unbalance- Each phase voltage should not differ more than 1 % from the average of the three. Current unbalance should not go beyond 10 %.

MEASUREMENT OF HARMONICS

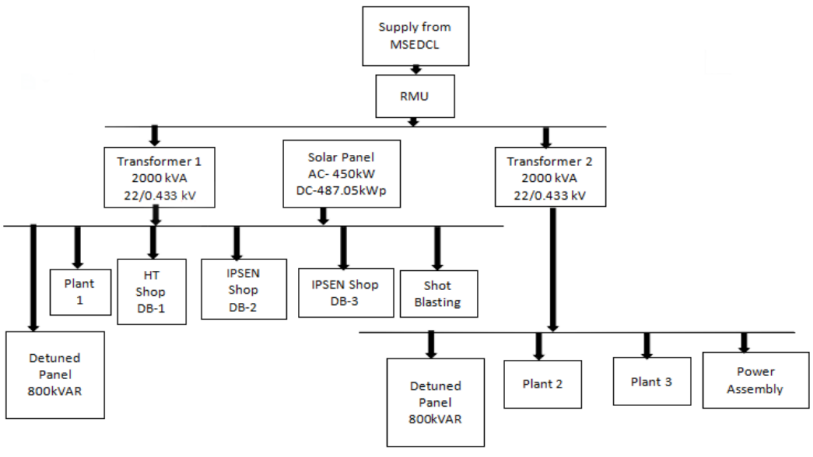

Figure 2 Sample Block diagram for case study

Sample block diagram for case studyis as shown in fig.2. Power analyzer Fluke 435-II was connected at Transformer 1, 2, solar panel and load of IPSENshop, plant 3.The connections of one of such process in shown in fig.3. Readings for half hourwas taken for eachmachine. After that, this data used for analysis purpose.

Figure 3 Connections of power analyzer

OBSERVATIONS

PowerLog software is used for analysis of data. From the collected data, current harmonics summary is plotted with IEEE limit. In fig.4 and fig.5such summary for IPSEN shop and transformer 1 is shown respectively.

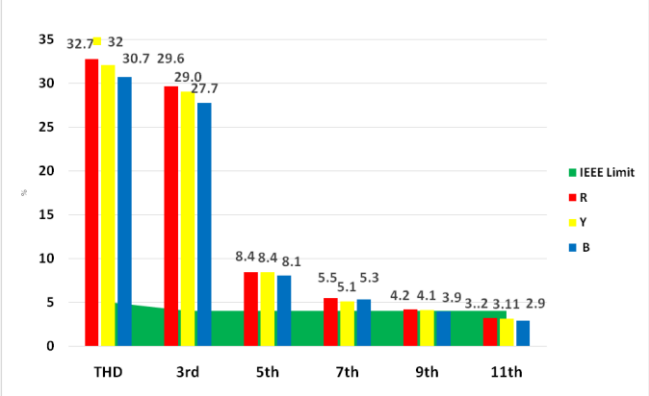

Figure 4 IPSEN Shop Current Summary

From this chart, it is observed that the 3rd harmonic is more dominant as 28.76% which is not within the limit as per IEEE limit shown in table no.1.

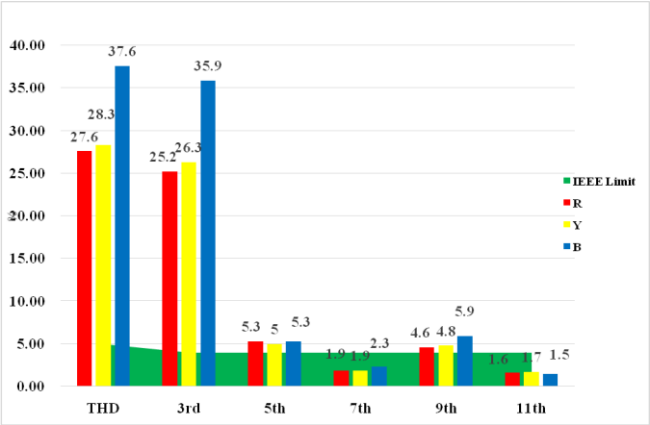

Figure 5. Transformer 1 Current Summary

From this chart, it is observed that the 3rd harmonic is more dominant as 29.13% which is not within the limit as per IEEE limit shown in table no.1

COMPARISON

IEEE 519-2014 HARMONICS LIMIT:

For the system under consideration as the PCC voltage is 0.433 kV applicable voltage harmonic limits are:

Individual harmonics (%)	Total Harmonic Distortion (%)
5.0	8.0

Table 1 IEEE 519-2014 Current Harmonics Limit

Bus Voltage at PCC	Individual harmonics (%)	Total Harmonic Distortion (%)
V≤1.0kV	5.0	8.0
1.0 KV ≤V ≤69kV	3.0	8.0
69kV ≤V≤ 161kV	1.5	8.0
161KV ≤V	1.0	8.0

Table 2IEEE 519-2014 Voltage harmonics Limit

By comparing the data with above standards, we noticed following points:

Transformer 1:

- Power factor of transformer 1 is slightly less (0.95).
- THD and 3rd, 5th and 9th harmonics are not within range as per IEEE limit.
- The total energy loss in rupeesfor transformer 1 for one year is ₹ 127059.75.

IPSEN shop:

- Power factor is poor (0.89).
- Due to APFC off THD and 3rd harmonics are dominated and are out of limit .

Transformer2:

- Power factor is poor(0.89).
- Harmonics and THD are not within the limit.
- The total energy loss in rupees for transformer 2 for a year is ₹212209.31

Plant3:

- Power factor is very poor (0.85).
- Harmonics and THD are within the limit.

Solar Panel:

- Power factor is unity.
- Harmonics and THD are within the limit.
- The total energy loss in rupees for solar panel in one year is₹432551.10

CONCLUSION

In the industry, power quality problems are major issues. They are causing dominant losses in the company. It is observed that harmonics of order 3^{rd}, 5^{th} are not within IEEE limit. So, corrective actions must be taken. Harmonic filter is suggested to filter out the harmonics.

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Voice Control Automation using Wireless Fidelity

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***Abstract*— In recent years advancement in electrical engineering and communication technology is mainly focused on internet of things. IOT means Internet of things which basically means that interlinking of various hardware systems with internet via various internet protocols. This concept has been implemented drastically for enhancing performance and reducing efforts in individual's lifestyle. In this paper we have designed and developed a system in which user can prompt a voice command on smartphone platform, that voice command will be received by wireless fidelity module. The wireless fidelity module is programmed microcontroller unit which send signals to the input and output ports. These signals help in triggering the switching component in the system which accordingly switches various loads connected. Our system is not an experimental prototype but a system embedded on the grid for daily use. The secondary system connected to IOT system is illumination elements and ventilation elements in the room.**

***Keywords*— Wireless Fidelity , Internet of Things , Voice Control , Automation , Smartphone Interface**

I. INTRODUCTION

As finely stated by Charalampos Doukas, a senior solutions architect at Alexa Skills Business Dev wrote in his book, "Building Internet of things using Arduino ", It says that "A global network infrastructure, linking physical and virtual objects using cloud computing, data capture, and network communications. It allows devices to communicate with each other, access information on the Internet, store and retrieve data, and interact with users, creating smart, pervasive and always-connected environments." The system designed is a compact version of modified switchboard which is employed by replacing traditional switch boards. It can be employed in the places where the switchboards are too far from the operating appliance. While employing the system the previous electrical network need not to be uprooted. It is the main advantage of this system that it can be located on the end tail of electrical networks.

The crucial part of the system is placement of Wireless fidelity Router. The placement of Wireless fidelity Router is significantly explained by Jason Cole, a scientist who is completing his PhD at London in Computational Physics. He worked out on Helmholtz Equation to trace the most desired co-ordinates where the wireless fidelity router should be placed with respect to co-ordinates of the connected appliances in the system. According to Jason Cole following are the points should be considered while placing a wireless fidelity router.

1. The positioning of the router can be done similar to concept of " Centre of Gravity " , the central spot with respect to workspace must be calculated and also signal deeming elements should be taken under consideration such as concrete walls and water bodies etc . By taking each of every co-ordinates the resultant co-ordinate should be plotted and there router can be placed.
2. Metals have ability to dissipate the electromagnetic energy , which disturbs the desired signal flow of the system.
3. While locating an antenna of router, it should be placed laterally upward so that the strength of signal is not hindered and it increases crabwise.
4. Just like concrete absorbs the signal and do not allow to flow through it , water also exhibits the same. Human body consists of 70% water, If the workspace is crowded it means there is more amount of water elements. There if the router is not placed at strategical point , there are chances where signals may get lowered.

The Hardware used for developing the system consists of a transformer, a bridge rectifier, a voltage regulator, few capacitors and few resistors. The main component of the system is ESP8266, which is wireless fidelity module of the system. Opto-Couplers are also employed to separate electrical circuit from electronic circuit. Traic is used here as switching component which receives signals from Wi-Fi module for switching actions. The Load is connected to respective traics. The current rating of respective traics are decided considering the ratings of the load.
The Software used in the system has a pivotal significance because the voice commands are transmitted from smartphone platform to Wi-Fi module through Internet protocols. Google assistant is employed here to read and transmit voice commands from smartphone platform to ESP8266. The android app called IFTTT is used to follow a programmed schedule for switching actions. IFTTT means " IF This Then That ", In the if column the input schedule is programmed and further columns the output response are programmed. This is used for operating via voice commands.
Another method is for operating via touch gesture. It is used for creating user interface for touch gesture. This is an Android app Called "Blynk". User needs to login using the google assistant credentials and this app gets synchronised to our system.

II. PROPOSED SYSTEM

A. Hardware

1) ESP8266

The ESP8266EX microcontroller integrates a Tensilica L106 32-bit RISC processor, which achieves extra-low power consumption and reaches a maximum clock speed of 160 MHz The Real-Time Operating System (RTOS) and Wi-Fi stack allow about 80% of the processing power to be available for user application programming and development. This module is programmed using Arduino IDE. It is responsible for receiving the signals from smartphone platform.

2) *Opto-Coupler*

PC-817 is also known as an optocoupler**.** It consists of Infrared Emitting Diode (IRED). This IRED is coupled to a photo transistor optically and not electrically. It is closed in a four-pin package. PC 817 has an internal LED and a photo transistor. The photo transistor's base becomes activate when LED throws light on it. The output obtained can be divided into two formats either common emitter or common collector. But the configuration is mostly common emitter. If the LED does not glow, transistor remains off and hence there will be no output generated by the optocoupler.

3) Voltage Regulator

It is three terminal linear voltage regulator IC with a fixed output voltage of 5V which is useful in a wide range of applications. Currently, the 7805 Voltage Regulator IC is manufactured by Texas Instruments. It can deliver up to 1.5 A of current (with heat sink). It has both internal current limiting and thermal shutdown features. We need to employ this component in our system because wireless fidelity module needs to be provided with the supply of constant 5V DC. The supply we get from rectifier in 12V DC. LM7805 lowers the voltage to desired voltage.

B. SOFTWARE

1) Google Assistant

Google Assistant can be synchronised to our routine chores. The daily apps we use can be operated with google assistant by prompting voice commands. The voice commands are recorded with respect to each input port , with variations in verbal commands. They are recorded and accordingly transmitted to wi-fi module. It is also very user friendly because all you need is google account credentials to login and use.

2) IFTTT

IFTTT service includes four different triggers, which are all variations on the same idea, It helps in creating phrases that you speak to Google Assistant. The triggers differ only in that some offer the ability to include a variable number, variable word, or both. Numbers and words can be passed as elements to be used with other supported IFTTT actions. It has widgets to choose from which we can build up our switching programmes.

3) Blynk

Blynk is a open source software platform that allows you to quickly build interfaces for controlling and monitoring your hardware projects from your iOS and Android device. After downloading the Blynk app, you can create a project dashboard and arrange buttons, sliders, graphs, and other widgets onto the screen. Using the widgets, you can turn pins HIGH and LOW or display data from sensors. It is employed for making switching operations through touch gestures in the system.

III. BLOCK DIAGRAM

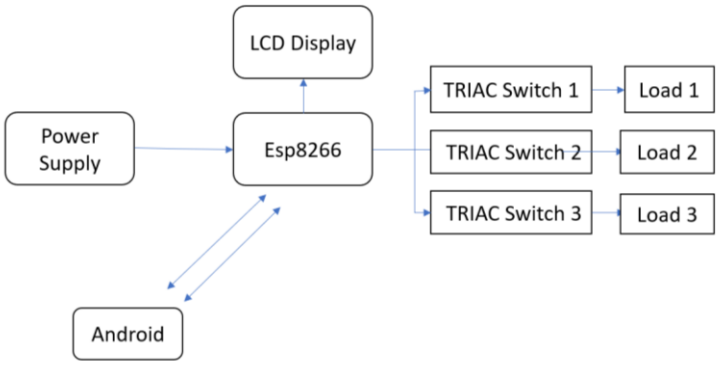

Fig 1) Block Diagram of Voice Controlled Automation

IV. CONCLUSION

In this paper, Automation is improved by employing a system called IOT based voice control Building Automation considering the main component as wireless fidelity module ESP8266. It interlinks the appliances via Wi-Fi and accordingly switching action takes place. There are two modes of operation provided. One is Active mode other is standby mode. In active mode, the system is operated as programmed. In standby mode we can use this system as traditional switchboard. We have designed and

developed a working model to be embedded in live grid in allocated institute workspace. From the experiment we found that we can manage the switching actions through voice commands. This system provides low cost, high security, flexible and comfortable solution than traditional system.

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Design and Control of Electric Bicycle

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Abstract: ***In present scenario petrol and other non-renewable sources are depleting day by day because of increase in usage these sources. This will cause increase of fuel price and causes carbon emission and degrades environment. Mostly these sources are petrol and diesel which is used by vehicles. For travelling longer distance there is no other alternative. But for shorter distance conventional bicycle can be use. These conventional bicycles can be modified with the help of motor and battery which can used for longer distance and these bicycles are called as electric bicycle. Further with the help of dynamo, battery can be charge with the rotation of wheel. This type of electric bicycle can be helpful in rural areas for farmers and students for travelling to their schools.***

Keywords: Electric Bicycle, Battery, Charging, Dynamo.

I. INTRODUCTION

In India fuel is imported from western countries and made available for public at high price. Petrol is nearly 80 Rupees per liter where in countries like America it is 10-15 Rupees per liter. For shorter distance conventional bicycle can be use, but if rider is exhausted by continuous peddling or he is more than 50 years old then external driving force is required. This can be achieved with the help of battery powered motor. Motor provides external driving force to bicycle and assist the rider to travel further. This electric bicycle is useful in hilly areas where more force is required for propulsion of the bicycle. This electric bicycle can useful in rural areas for farmers for reaching their farms and for students for reaching their school which will save their time. Further by using dynamo batteries can be charged by using dynamo when rear wheel starts rotating. [2] By using electric bicycle where it is possible will reduce burden on the motorcycles, will reduce the carbon emission and improve quality of air. For electric bicycle there is no need to purchase whole bicycle, if person is having conventional bicycle, he can attach the components to bicycle can convert it into electric bicycle.

II. OBJECTIVES

These are the objectives which are obtained by competition of the project: -

A. Upgrading the conventional bicycle
B. Charging of the battery while using it
C. Cost Effective
D. Reduction in traffic
E. Reduction in pollution and use of petroleum products

III. WORKING OF BLOCK DIAGRAM

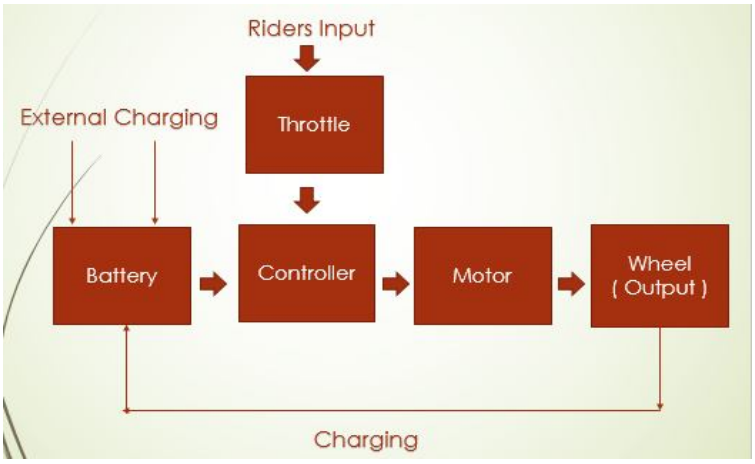

Fig. I: Block Diagram of Electric Bicycle

Rider gives input to the controller by twisting the throttle. Supply is given to the motor through controller. As per input given by rider, controller will give or adjust input to the motor. Motor is connected to the rear wheel of the bicycle which is connected by gear and chain. Dynamo is connected to the rear wheel of bicycle. As the rear wheel rotates dynamo generates electricity, which is use for charging the battery. Battery also ca be charged externally.

IV. METHODOLOGY

These methodologies can be used for fabrication of electric bicycle: -

Design Part	Methodology Available
1. Motor	1. Brushed DC Motor
	2. Brush less DC Motor
2. Motor Assembly	1. Gear Type
	2. Hub Motor
3. Battery Type	1. Lead-Acid
	2. Lithium-Iron
4. Throttle Type	1.Twist Type
	2. Push Button Type

V. SPECIFICATIONS

Assumptions made are: -
Total Mass of bicycle including rider = 10Kg
Diameter of Wheel = 26 Inches / 0.6604 Meter
Velocity = 20 Km/Hr

Component	Rating
1. Motor	250 W, 24V, 10A, 11.4 Nm,
2.Battery	12 V, 7.5 AHr (2 Nos.)
3. Charger	24 V, 1.5-2 AHr
4. Dynamo	12V, 6W (2Nos.)

Battery Related Specifications:

Time Required to Discharge the Battery	43 Min
Time Required to Charge the Battery with Charger	225 Min (3 Hours 45 Min)
Time Required to Charge the Battery with Dynamo	900 Min (15 Hours)
For Velocity of 20 Km/Hr Speed of the Motor is 161 RPM.	Therefore, bicycle will run for 14 Km in one full charge of the battery.

VI. WORKING OF EACH COMPONENTS

A. Permanent Magnet DC Motor

In PMDC (Permanent Magnet DC) Motor, stator is consisting of permanent magnet and rotor/armature having n copper winding. When supply is given to armature, current will start flowing through winding. This will cause current carrying conductor placed in magnet field and force will get apply on the conductor, this will cause armature starts rotating. Depending on voltage applied to the armature speed and torque will get changed.

B. Battery

A battery is a device that converts chemical energy directly into electrical energy. It consists of a number of voltaic cells; each voltaic cell consists of two half-cells connected in series by a conductive electrolyte containing cations and anions. Lead-acid battery is consisting of lead oxide electrode (PbO2), sponge lead and acid (H2SO4). Chemical reaction: -

PbO4+H2SO4+Pb=PbSO4+2H2O+PbSO4+Energy

This chemical reaction is reversible i.e. for charging and discharging.

C. Throttle/Accelerator

Throttle works on Principle of Hall Effect. Hall effect sensor will sense the mechanical position and will gives output accordingly.

D. Dynamo

Dynamo converts mechanical energy i.e. motion into electricity like small rating generator.

VII. FUTURE SCOPE

Our project “Design and Control of Electric Bicycle” is mainly focus on designing parameters of motor and battery and charging system. This bicycle further can be improved by using higher rating dynamo for charging or using additional solar panel for charging of the battery and by using Lithium-Iron battery. Lithium-Iron battery requires less space than Lead-Acid battery and having feature like fast charging, therefore Lithium-Iron battery with higher capacity will help to replace fossil fuel vehicle for travelling shorter distance.

VIII. RESULT AND TESTING

“Design and Control of Electric Bicycle” was designed for improving conventional bicycle and reducing use of fossil fuel vehicle for shorter distances. By adding dynamo for charging of the battery will improve battery performance and increase the discharging time of the battery, which will help the bicycle to travel longer distance.

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Integrated Wind, Solar And Energy Storage

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ABSTRACT :

Energy is the golden thread, a crucial factor that is connecting economic growth, social equity and develops a environment that allows world to thrive. Integrated wind, solar and energy storage is co-locating renewable energy source of wind and solar and thus integrating them into a single plant. The recent state of art hybrid energy system technological development is the result of activities in a number of research areas, such as Advances in electrical power conversion through the availability of new power electronic semiconductor devices, have led to improved efficiency, system quality and reliability. Development of versatile hybrid energy system simulation software; continuing advances in the manufacturing process and improve efficiency of photovoltaic modules. The task for the hybrid energy system controller is to control the interaction of various system components and control power flow within the system to provide a stable and reliable source of energy.

Keywords : **e**nergy , Integrated , efficiency , electronic semiconductor devices

INTRODUCTION

COLOCATING WIND AND SOLAR GENERATION with battery energy storage is a concept garnering much attention lately. An integrated wind, solar, and energy storage(IWSES) plant has a far better generation profile than standalone wind or solar plants .It results in better use of transmission evacuation system, which , in turn ,provides a lower overall plant cost compared to standalone wind and solar plants of same generating capacity. These plants are particularly suitable for regions that have set high targets for wind and solar generation but have limited land available for project development.

Renewable energy sources, such as photovoltaic, wind energy, or small scale hydro provide a realistic alternative to engine-driven generators for electricity generation in remote areas . It has been demonstrated that IWSES systems can significantly reduce the total lifecycle cost of standalone power supplies in many situations, while at the same time providing a more reliable supply of electricity through the combination of energy sources.

Separate wind and solar plants connected to same point of interconnection do not constitute an integrated wind and solar plant. In an IWSES plant , wind turbines, (PV)solar arrays , and a battery energy storage system(BESS) are integrated into a single plant using state-of-the-art controls, These integration can be performed at different levels.

The aim of this paper is to review the current state of design and operation of integrated energy system ,and to present future developments , which will allow a future expansion of markets, both in industrialized and developing countries.

NEED OF INTEGRATING RESOURCES

According to renewable energy experts, a small IWSES electric system that combines wind electric and solar electric (photovoltaic or PV) technologies offers several advantages over either single system. In much of the United States, wind speeds are low in the summer when the sun shines brightest and longest. The wind is strong in the winter when less sunlight is available. Because the peak operating times for wind and solar systems occur at different times of the day and year, hybrid systems are more likely to produce power when you need it. They are Complementary to each other. Intermittent in nature. For the times when neither the wind nor the solar system is producing, IWSES provide power through batteries and/or an engine generator powered by conventional fuels, such as diesel. If the batteries run low, the engine generator can provide power and recharge the batteries. The solar and wind both require robust electrical and power evacuation infrastructure. The storage

capacity of these systems must be large enough to supply electrical needs during non-charging periods. Battery banks are typically sized to supply the electric load for one to three days. Thus combining these resources is more convenient as they complement each other, requirements such as for land, equipments, machinery labor and skill sets required is almost the same .As well as there is reduction in cost which is elaborated further.

WORKING

The IWSES as stated earlier does not have wind and solar plant connected to the same point of interconnection .In IWSES plant; wind turbines, photovoltaic solar arrays, and battery energy storage system (BESS) are integrated into a single plant using state-of-art controls.

This integration is carried out in two ways

1. Wind turbine/PV array level.
2. Farm level.

- In farm level integration, balance-of-plant(BOP)equipment such as transformers and switchgears ,as well as the upstream transmission evacuation system ,is shared by wind, solar and BESS. In turbine level integration, each converter may be potentially shared by a wind, solar and BESS resource.

Thus in favorable conditions these plants generate energy. The electric energy generated from wind needs to be converted from AC to DC ,for purpose of transmission .The PV panel already generate DC supply where as the stored energy in batteries is chopped into favorable DC. This DC output's from all the sources is connected to a DC bus from where it is converted into AC supply for regular household and industrial applications.

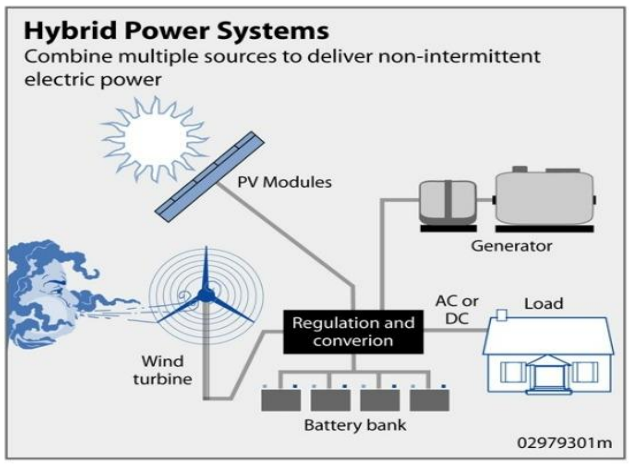

Figure.1:Block diagram of integrated system

DESIGN

According to the IEEE references ,a techno-economic feasibility study for IWSES plants was completed for two sites in India i.e. in Anathpur, Andhra pradesh; and Kutch, Gujrat.This study was performed for the Infrastructure Leasing & Financial Services Energy Development Company Limited,a developer and financier of renewable projects in India under a technical assistance grant from the U.S. Trade and development agency.

The deliverables of this study were as follows:

✓ Developing the technical design of the IWSES plant ,including the transmission evacuation plan

✓ Developing use cases for integrated energy storage appropriate for the Indian system

✓ Sizing energy storage to provide multiple plant and system-level services

✓ Performing cost-benefit analyses of IWSES plants under existing and proposed regulations

✓Preparing high-level environmental and social impact analysis guidelines

✓ Outlining the financing plan for the projects using viability gap funding and other incentives to supporting infrastructure projects that are economically justified but fall short of financial viability

✓ Recommending regulatory and policy changes required to integrate energy storage in India

✓ Conducting a reverse trade mission for Indian regulators and policy makers to learn about the energy storage business in the United States.

DESIGNING CONSIDERATIONS FOR AN INTEGRATED WIND-SOLAR PLANT

When designing an integrated plant, it is important to ensure that the interaction between the wind and solar plants is captured and taken into consideration. There are two principal types of interactions that must be modeled: 1)The effect of the turbines on the PV arrays . 2) The effect of the PV arrays on the wind-flow field.

The siting of the turbines was carried out first because the wind resource was more variable across the site than the solar resource; therefore, the optimum configuration of wind turbines is more sensitive to their siting than that of the solar array.

The presence of the PV panels can impact the surface roughness and affect the wind flow through the turbine array. An array of solar panels can be similar to other topographic or locational features (trees, buildings, etc.) ,in that it alters the surface roughness and affects wind flow through the array. Increased surface roughness changes the profile of the atmospheric boundary layer as it flows across the array, increasing the shear effect.

The approach for roughness modeling, turbine wakes, and the impact on wind flow is based on a theory advanced by Sten Frandsen. Frandsen stipulates that an infinite array of wind turbines is represented as a region of uniform high-surface roughness. The roughness imposes drag on the atmosphere, causing both a downstream change in the structure of the boundary layer and a reduction in the free-stream wind speed at the turbine hub height. At the project sites, the effect was comparable to that of the local vegetation.

Figure.2:Site favourable for IWSES (only for reference purpose)

BENEFITS OF IWSES

- ***Benefits from Integrating Wind and Solar Generation:***

The key benefits of an integrated wind-solar plant relative to standalone wind and solar plants with the same cumulative capacity are as follows:

1. Decrease in Project development cost:

Many factors are to be considered while designing solar or wind , like its impacts on markets , impact on environment , also some legal factors are to be considered. Which are as follows;

- Licence /permits
- Power purchase agreements
- Land lease
- Construction permits

Thus effective decrease in the cost is possible due to integration because tje legal procedures for both plants is the same.

2. Better use of available land:

- Collocating wind and solar power plants conserves space and increases the energy density (i.e., the amount of energy produced per acre of land).
- In many wind plants, the land between the turbines is often left unused. To make better use of space, wind and solar plants can be collocated, provided that conditions for both wind and solar power generation are favorable at the same location. Alternatively, if wind and solar plants can be sited adjacent to one another, they can share the same transmission evacuation infrastructure.

3. Complementary generation profile:

A further benefit of integrating wind and solar generation stems from the complementary nature of both the diurnal and seasonal patterns of their generation.

- the average hourly generation during selected months for a wind-solar plant made up of roughly 500-MW each of wind and solar generation capacity.

wind generation dips during the day and increases late in the evening. On the other hand, solar generation follows the sun and is highest during the middle of the day. Combining wind with solar reduces the difference between the generation levels during daytime and night time periods.

4 .Potential savings in transmission evacuation costs:

- An integrated wind-solar plant also has the potential for savings in evacuation and transmission upgrade costs.
- Typically, in a wind or solar plant, the collector system is designed to carry the maximum output of the plant. For example, standalone 100-MW wind or solar plants would each have 100 MW of evacuation capability.
- However, an integrated plant can make do with an evacuation capability lower than 200 MW because wind and solar generation will not peak at the same time. a range of cumulative hourly generation during selected months for a 1,000-MW wind-solar plant. Here the average cumulative hourly generation bounds within which the cumulative generation for each hour would occur 95% of the time.
- It is, thus, possible to design the evacuation system with a rating lower than the sum of the maximum capacities of the wind and solar plants.

CONCLUSION:

With increasing demand for energy and hikes in prices of non-conventional energy resource ,a future perspective should be considered .Even though the initial cost of set up is high ,long term savings and energy conservation is achieved.

It also supplies continuous power to the load with optimum design to control cost.

The IWSES energy systems are recognized as a viable alternative to grid supply or conventional, fuel-based, remote area power supplies all over the world. The literature review reveals that, renewable energy based low emission hybrid systems are not cost competitive against conventional fossil fuel power systems .However, the need for cleaner power and improvements in alternative energy technologies bear good potential for widespread use of such systems. Moreover, the rural households in industrialized and less developed countries attach high value to a reliable, limited supply of electricity. Community facilities such as rural hospitals, schools, telecommunication and water pumping stations can contribute significantly to the welfare of people and rural development. While it is recognized that technology can only be one aspect of community development, the renewable energy systems have demonstrated the potential to provide support in some of the basic infrastructure needs in remote and urban areas for different application.

Next steps for IWSES in India

The Ministry of New & Renewable Energy in India plans to add yet another record-breaking project in its portfolio .

Mega project capacity :160MW

Area:1000 acres

Investment:1000 crore(155 million $)

Developed by: Solar Energy Corporation of India (SECI), the renewable energy agency of Andhra Pradesh, Andhra Pradesh Transco.

120MW solar and 40MW wind power

Future of IWSES in other countries,

FORT HOOD, Texas (Jan. 28, 2016) -- Fort Hood, federal and local officials broke ground here during a ceremony for a massive energy project for the installation, Jan. 28.

The project, the largest and first of its kind, will include both an on-post solar farm and an off-site wind turbine farm, which has the capacity to generate 65 megawatts of electricity for the installation, saving taxpayer money during the duration of the contract. The upstart capital of the project will be $100 million.

Its main objective is to free up money to be able to make better Soldiers here on Fort Hood. So, if it's cheaper energy, it gives us more money to the military to spend on training up the best warriors in world.

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Fabrication of maximum power point tracking solar charge controller

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Abstract- **There are inherent power losses that occur when the solar is connected directly to a load/battery without matching their internal impedances. In addition to the non-linear (I-V) operating characteristics of a PV module associate degreed variations in its output power with star insolation and in operation temperature . MPPT charge controller is employed in most alternative energy harvest home systems to ensure that maximum rated power is drawn from the solar panel and is delivered to the battery while charging it in a healthy mode to increase its lifespan and for efficiency purposes under varying atmospheric conditions.**

Keywords- **Arduino, MPPT, Solar panel, Batttery.**

I. INTRODUCTION

Renewable energy sources are becoming an alternative to traditional fossil fuels due to their advantages of being clean and inexhaustible mainly. Solar power is one of the renewable energy sources and although it has a high potential its generation efficiency (conversion of solar energy to electricity) is low with most commercial solar panels having efficiencies of less than 30%. With this already low power generation efficiency of solar panels it is only necessary that the maximum power is sourced from that generated by solar panels to ensure high efficiency in delivering power to the load to make solar power an effective alternative and justify its high installation costs too. Since the I-V characteristics of solar panels vary with atmospheric conditions such as irradiance, more power can be received out of solar panels by direct methods e.g. solar tracking (panel mounted on frame and rotated with help of motors) to track the sun as it moves across the sky or by indirect methods e.g. Maximum power point tracking the latter being in the purview of this project. Using MPPT charge controllers reduces variety |the amount |the quantity} of PV modules that require to be put in to get a definite power by increasing the facility generated from the important number of PV modules needed to generate the power at high efficiency. Using MPPT charge controllers we actually find or track the exact value of voltage and current to obtain the maximum power. This is done by MPPT algorithms. There are various methods to make these charge controllers like P&O Technique , Open circuit voltage (OCV) technique ,Short Circuit Current(SCC) Technique Incremental conductance method.

II. METHODS

Charge controllers aim to supply the proper voltage and current ratings for a rechargeable battery by observation and control the electrical device output voltage to match the batteries. This output voltage regulation is very important in battery charging because batteries require a specific charging method with various voltage and current levels for each specific stage, these charging methods are required to prolong battery life and performance. Some common charge controller protection options to stop battery harms are undercharge and overcharge protection. Undercharge protection entails disconnecting the battery when the charge is too low to continue powering connected loads and battery is connected to charging via controllers .Similarly the charge controller stops providing energy to the battery when it is fully charged to prevent overcharge. This is where the charge controller does most of the work .Simple charge controllers disconnect the battery once the battery surpasses a threshold level and reconnect it once the battery level falls below a certain preset charge level. Implementing a DC to DC converter rather than a linear regulator (or just connecting the battery directly to the solar panel) ensures considerably higher power efficiency.

There are various types of solar charge controllers –

1. On / Off – This type of controller continuously monitor the charging level of battery, when it achieves a certain value then it disconnects the circuit from charging.

2. Pulse Width Modulation- In this Method we use the algorithm for Switching of MOSFET to vary the current and keeping the voltage level constant . This is done by setting the duty cycle of the Mosfet.
   The circuit disconnects after the battery voltage reaches the threshold value.

3. Maximum Power Point Tracking (MPPT) Solar Charge Controller- This has the highest efficiency of all the other methods . There are various ways to track the Maximum Power Point. Few of them are illustrated below :-
   a) Perturb and Observe Method- We have used this method in implementing our project. This is most simplest method and is used in most of the cases. It keeps on perturbing on both sides of Maximum Power Point along the P-V curve to obtain highest power from solar panel. The drawback of this method is that when the irradiance level changes rapidly then it gives false MPP point.

   b) Incremental Conductance Method- In this method we use current and voltage sensors on both sides towards the input and output. This works on principle that the slope dp/dv is zero at the maximum power point. Now Power= V*I , hence we are sensing both current and power. This reduces the error due to change in irradiance . But the system complexity increases. Also cost is high.

   c) Open Circuit Voltage Method- The relation between the open circuit voltage and Vmpp of the PV array is defined in this method.

   $$Vmpp = k1*Voc$$

   Now the k1 depends on the P-V characteristics of the solar panel used. Hence it has to be calculated before its implementation. The relationship between the Voc and Vmpp at different temperature and irradiance levels.

   d) Short Circuit Current- This methods works on the principle that the short circuit current and maximum power current are linearly related

   $$Impp = k2*Isc$$

   Where K2 is proportionality constant. It's value ranges from 0.78 to 0.92 .There is a switch provided to the converter to short the PV array after small durations to measure the short circuit current with help of current sensors.

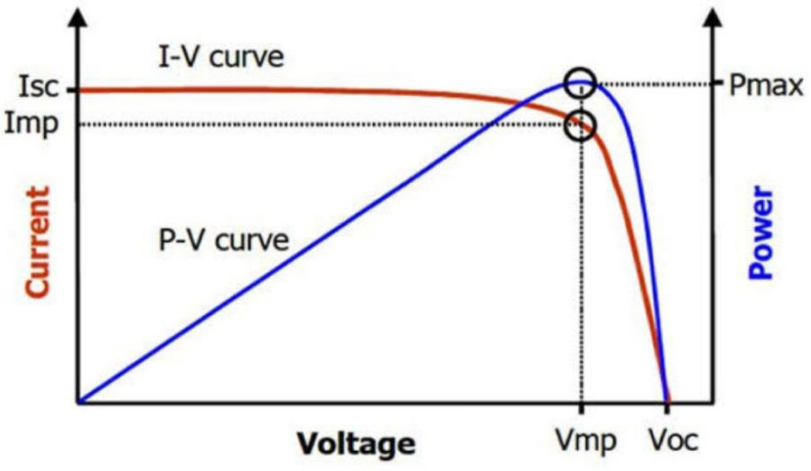


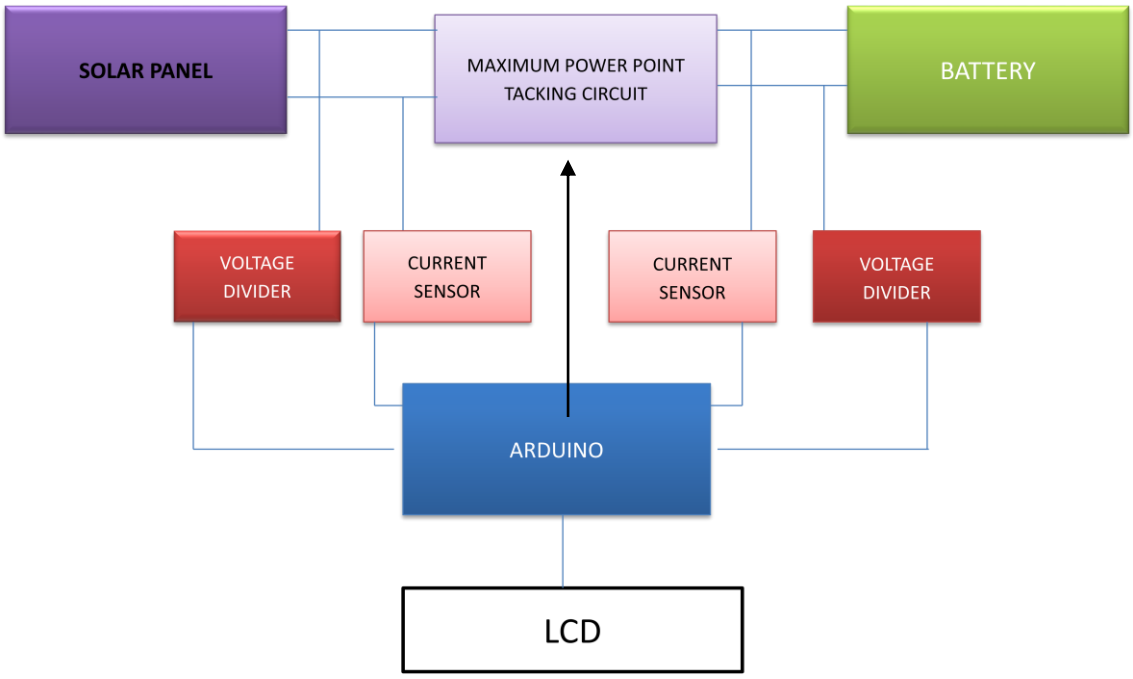
Figure shows the I-V Characteristics and Corresponding Power of Solar Panel.

III. WORKING

In this particular prototype of MPPT in solar system, solar panel is connected to the a battery through a Maximum Power Point Tracking (MPPT) circuit .MPPT circuit consists of DC-DC converter .Current sensors (ACS712) and voltage sensors(voltage divider) are connected between solar panel and MPPT circuit to sense the input voltage and current of the solar panel and same function is of the sensors between MPPT circuit and battery to sense battery voltage and battery current. For the different instances throughout the day the output of solar panel is different which depends on temperature and the irradiance level .So different V-I curves are drawn for different values throughout the day. So peak point or the knee point on that curve is the point of maximum power or Maximum Power Point .Let us consider a solar panel of 10 watt with 21 v open circuit voltage , whose current is 0.47 amps,directly connected to a battery of 12 volt ,as the impedances of storage and source do not match voltage at source comes to the level of voltage at storage , where current is fixed at 0.47 amps. So the current is actuated by the sunlight at that instance.Now the power,

$$P = V \times I = 12 \times 0.47 = 5.64W.$$

Here panel acts like a 6 watt panel. Efficiency becomes 10W-5.64W = 4.36W (42.36%).Here, we need proposed the controller. So the proposed controller comprises the DC-DC converter use to boost the voltage with the corresponding change in duty cycle. and it's duty cycle or gate pulse to the switch (here MOSFET) is controlled by arduino. The values of current and votages are displayed on a 16x2 LCD. The method we used is P&O method which compares the power at different voltages to obtain the maximum power. The output Power oscillates near the maximum power point.



BLOCK DIAGRAM OF THE SYSTEM

IV. ADVANTAGES

Using MPPT charge controller we can avoid harms to the battery like overcharge and undercharge condition which reduces battery life .It has capacity to utilize higher output voltage to deliver more power .The need for more power generally followed by the costly purchase of extra solar panels can be reduced at least to some extent by increasing the efficiency in the existing system.

V. FUTURE SCOPE

For more stability while obtaining the maximum power point more complex but effective methods like incremental conductance can be implemented in near future .One could power the DC-DC converter along with the arduino directly through the solar panel ,hence no need to use the power adapter .Also in near future AC loads can also be supplied using some techniques . As the efficiency will increase existing panels will be able to supply more load than without using controllers. Also it will prevent over charging and under charging.

VI. Conclusion

This paper explains the a model of a solar system with MPPT charge controller, along with the storage system. So, by this we are introducing a prototype model showing the design for the solar charge controller controlled by PWM. We focused to give the solution which will be on the basics of the current and voltage sensors and microcontroller as Arduino and the dc-dc converter controlled by arduino.We aimed to increase the efficiency of solar power transfer from solar panel to battery .We tried to reduce the need of the manual monitoring of solar system .

VII. Acknowledgement

The authors are thankful to All India Shri Shivaji Memorial Society and Principal Dr. P. B. Mane for providing healthy Teaching-Learning atmosphere at the institute. Also the authors are thankful to the teaching and non-teaching staff for their guidance and help in completion of the project.

VIII. References

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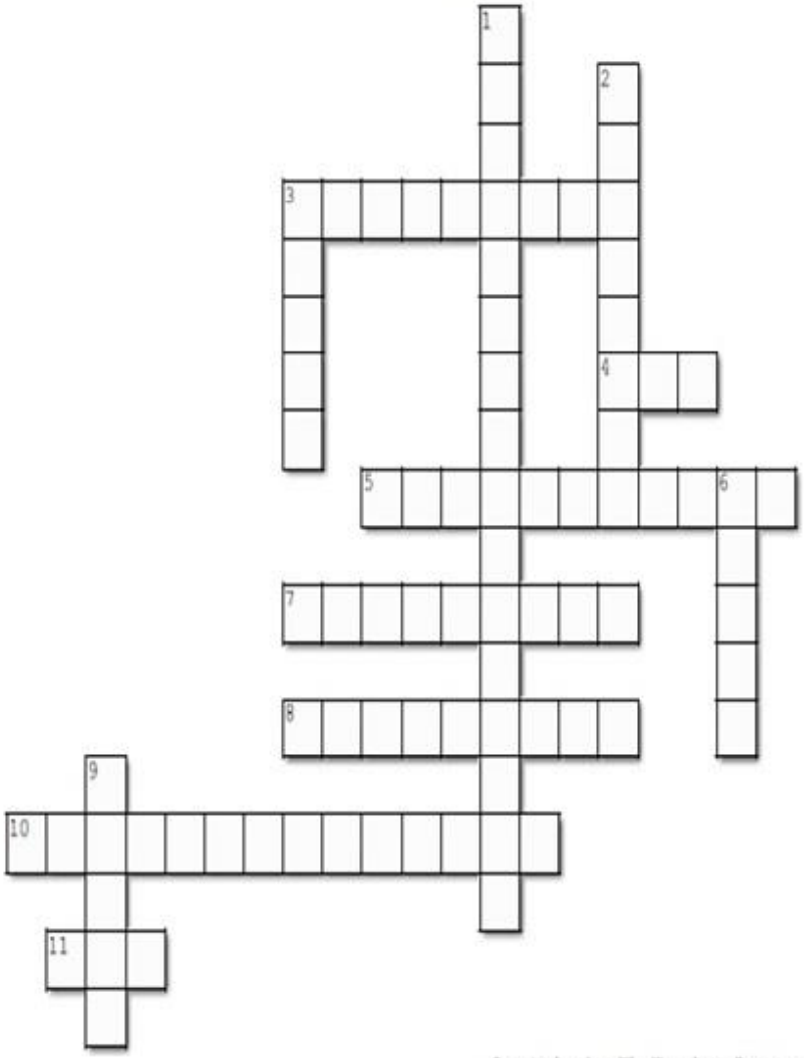
Smart Grid Crossword

Prof. S. M. Shaikh

Complete the crossword below using knowledge of Smart Grid



Created using TheTeachersCorner.net Crossword Puzzle Maker

Across

3. 1. The key feature of a smart grid- _____control

4. 5. According to Albert Betz, the maximum efficiency of wind power generation system is

5. 4. The IEEE standard for- Method of evaluating a Phasor measurement unit (PMU) measurement and requirements

7. 10. Q-axis sinusoidal disturbance current injection results in perturbations majorly in

8. 11. The operating time of rate of change of frequency (ROCOF) relay _____with the increase in inertia of machine

10. 14. In the hybrid storage system which device helps to compensate for high frequency switching transients

11. 9. The performance of current injection-based islanding detection techniques is superior for loads of _____quality fact

Down

1. 17. In a typical AC microgrid the following helps to regulate voltage and frequency in the islanded mode of operation

2. 3. the following standard is used to provide criteria and requirements for the interconnection of distributed generation reso

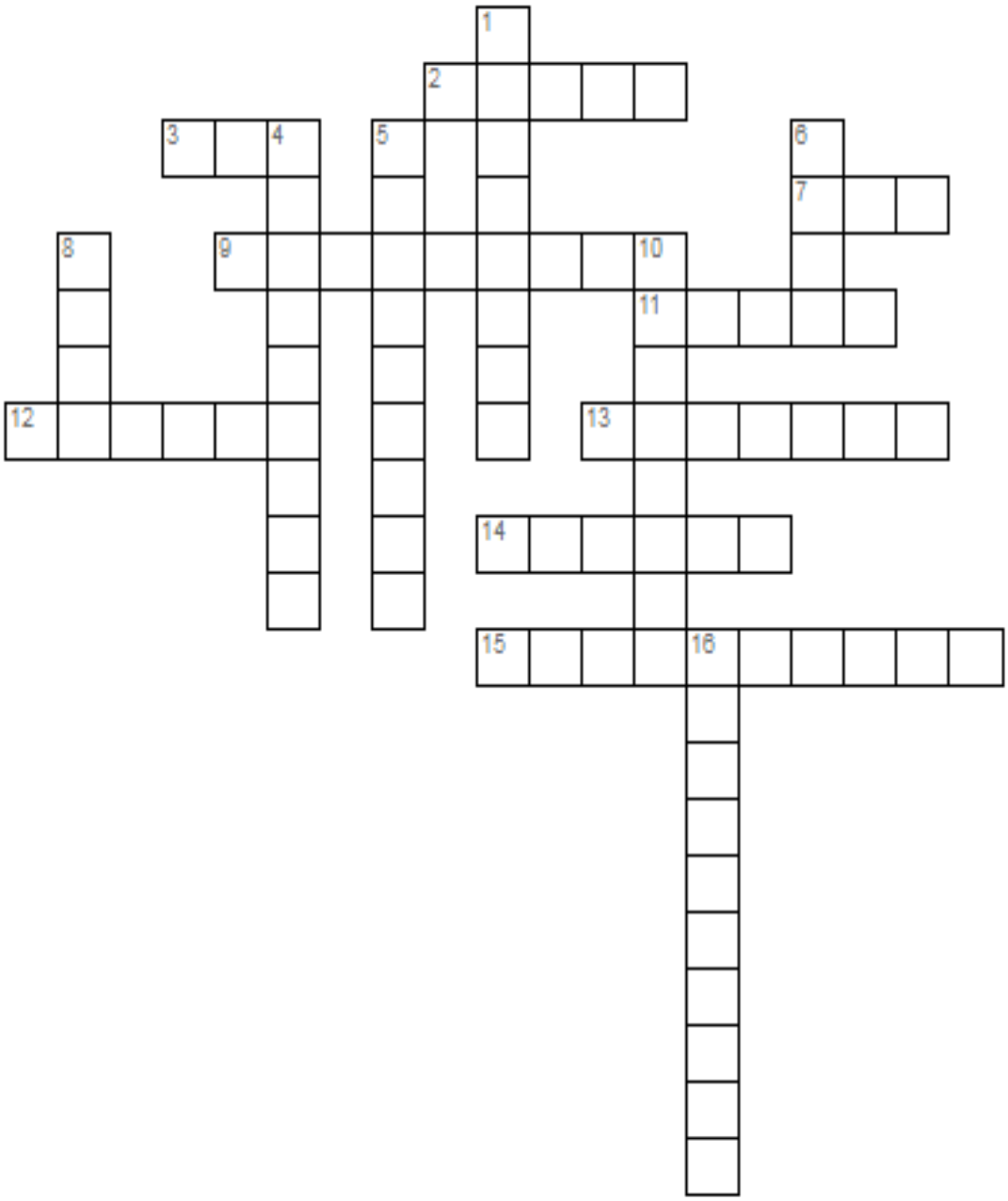
3. 13. Directional relays respond to

6. 2. PV installation target of India by 2022

9. 8. In case of digital relays, various relay settings are stored in

Basic Electrical Crossword

Prof. S. N. Pawaniker



Across

2 passage of current through body
3 wiring size
7 a law
9 measures electrical potential
11 a type of ground
12 symbol 'T'
13 enclosed path of current
14 to turn on and off current
15 electromagnetic wave

Down

1 measures electrical resistance
4 reference point in an electrical curren
5 measures electric power
6 symbol 'V'
8 protects against excessive current
10 electric component that transmits current
16 generates a continous output waveform

Suduko

Prof. A. D. Shiralkar

	2	7	1	4		8		6
8			7		5		3	
	3	9			8		7	5
7	5	4		3	1			9
		2		5		7		
1	9		2	6		5	4	3
9			3		2	6	5	
	7		5		6		1	
6		5		1	9	3		7

8		1	2		2			5
4		7		8		3	1	
	2			6		8		9
	5	3		2	4	6	8	
9		6	1		8		3	7
	8		3	7		9	5	
6		9	8		2		4	
	1	4		9		7		8
2	3		7		5	1		6

Electrical Quiz

Prof. K.S Gadgil
Prof. V.A Yawale
Prof. N.M Rao

1) Materials with lots of free electrons are called

- A. conductors
- B. insulators
- C. semiconductors
- D. filters

2) Eight-tenths coulomb passes a point in 4 s. The current in amperes is

- A. 1.6 A
- B. 16 A
- C. 2 A
- D. 0.2 A

3) A wiper is the sliding contact in a

- A. switch
- B. photoconductive cell
- C. thermistor
- D. potentiometer

4) A 120 Ω resistor must carry a maximum current of 25 mA. Its rating should be at least

- A. 4.8 W
- B. 150 mW
- C. 15 mW
- D. 480 mW

5) Three 47 Ω resistors are connected in parallel across a 110 volt source. The current drawn from the source is approximately

- A. 2.3 A
- B. 780 mA
- C. 47 mA
- D. 7.06 A

6) A practical current source has a finite internal resistance.

- A. True
- B. False

7) The duty cycle of a pulse waveform with a pulse width of 10 µs and a period of 100 µs is 25%.

- A. True
- B. False

8) What is the capacitance when Q = 60 µC and V = 12 V?

- A. 720 µF
- B. 5 µF
- C. 50 µF
- D. 12 µF

9) A transformer with a 110 V primary has a 15:1 turns ratio. The load resistance, R_L, is 120 Ω. What is the approximate voltage across the load?

- A. 7.3 V
- B. 73 V
- C. 88 V
- D. 880 V

10) A transformer

- A. changes ac to dc
- B. changes dc to ac
- C. steps up or down dc voltages
- D. steps up or down ac voltages

11) The resistor voltage in an *RL* circuit is always out of phase with the current.

A True B. False

.

12) An *RL* high-pass filter consists of a 470 Ω resistor and a
taken across the coil. The circuit's critical frequency is

- A. 125 Hz
- B. 1,250 Hz
- C. 564 Hz
- D. 5,644 Hz

13) If the capacitor in an integrator becomes leaky,

- A. the time constant will be effectively reduced
- B. the waveshape of the output voltage across *C* is altered
- C. the amplitude of the output is reduced
- D. all of the above

14) The rising and falling edges of a pulse waveform contain the higher frequency component.

- A. True
- B. False

15) If the rms voltage drop across a 15 kΩ resistor is 16 V, the peak current through the resistor is

A. 15 mA

B. 1.5 mA

C. 10 mA

D. 1 mA

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Power Quality Audit of various industries done by Mr. S. V. Shelar with students

Indian Society of Lighting Engineers Activities

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IEEE Activities

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