



# **ENERGETICS**

**K.S.R. COLLEGE OF ENGINEERING**

**TIRUCHENGODE - 637215**

**VOLUME 23 | ISSUE 01 | DECEMBER 2024**

# **K. S. R. COLLEGE OF ENGINEERING**

**An Autonomous Institution**

(Approved by AICTE, Affiliated to Anna University, Accredited by NAAC A++ Grade)

**K.S.R. Kalvi Nagar, Tiruchengode - 637215, Namakkal District, Tamil Nadu.**



**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING**

## ***ENERGETICS'25***

**TECHNICAL MAGAZINE**

**(Volume 23 / Issue 01 / December 2024)**

**ACADEMIC YEAR 2024-2025**

With the Blessings of our Beloved Founder's



*Forever in our hearts,  
Forever in our thoughts!*

## *Chairman's Message*

*Vision looks in ward and become duty.*

*Vision looks outward and become aspiration.*

*Vision looks upward and become faith.*



**Shri R. Srinivasan BBM., MISTE.,  
Chairman, KSR Educational Institutions.**

As we stand on the brink of new beginnings and boundless possibilities, I am filled with an immense sense of pride and optimism about what we can achieve together at KSR Educational Institutions. Our founder, Dr. K S Rangasamy, laid a strong foundation rooted in the belief that education is the most powerful tool to transform lives. Carrying forward his legacy, we remain committed to not just educating but empowering young minds to make a meaningful impact in the world.

In today's fast-paced, technology-driven society, the challenges are as dynamic as the opportunities are great. It is imperative for education to transcend traditional learning and encompass the development of holistic, innovative, and critical thinking skills. At KSR, we strive to equip you, our students, with the capabilities to not only adapt to changes but to drive them. We are dedicated to nurturing a generation of leaders, innovators, and thinkers who are ready to take on global challenges with local sensibilities.

Making an Impact is not just a phrase—it's our mission. It's about inspiring each one of you to pursue your passions with determination and a sense of responsibility towards the betterment of society. We encourage you to dream big, push boundaries, and question the status quo. Our campus is a melting pot of ideas where your creativity and ambitions are nurtured, allowing you to flourish in ways you never imagined.

## *Principal's Message*



**Dr. M. Venkatesan**  
**Principal – KSRCE**

As a Principal of KSRCE, I actively play my role to facilitate students to become best academicians, researchers and policy makers. I provide a diverse and inclusive work environment to my colleagues and drive them wherever necessary to play a role in getting utmost national and international agencies support Institution. A collaborative and integrated approach towards teaching, learning and research will be emphasized. I strongly believe that the KSRCE team will overcome the constraints facing to deliver the best Engineering services to the society and reach the desired goals.

## *HOD'S Message*



*Prof. Dr. S. Ramesh,  
Head of the Department - EEE*

As the summer sun glows pleasantly to heat up everything, the creativity and talents in every techie of our department is thirsty to project his/her talents and skills. On behalf of the editorial board, proudly presenting **ENERGETICS 2025** designed with a vision to quench the thirst by layering a platform for innovative ideas.

The soul of creativity lies in the dream to unveil inherent talent. The power of this dream fuelled us forward and made **ENERGETICS 2025**, a reality. We are thankful to all who contributed to fulfil our dream. First and foremost, let me thank our chairman who was always with us, to provide a wonderful platform to nourish the talents. I extend my sincere thanks to our Dean, Principal who were always in the forefront to encourage and inspire to execute wonderful ideas. I thank all students and faculty coordinators for their overwhelming support to bring out **ENERGETICS 2025**. I also wish all outgoing students of 2025 a bright future ahead.

**"Dream, Dream, Dream transfer into thoughts and thoughts result  
in action Success will be yours."**

**-Dr. A. P. J. Abdul Kalam**

## ***ENERGETICS' 2K25***

### ***CHIEF PATRON***

**Shri. R. Srinivasan**

Chairman, KSR Educational Institutions

**Mr. K. S. Sachin**

Vice Chairman, KSR Educational Institutions

### ***PATRON***

**Dr. M. Venkatesan,**

Principal, K. S. R. College of Engineering

### ***ADVISORS***

**Dr. R. Jeyabharath,**

Mentor, EEE

**Dr. S. Ramesh,**

HoD, EEE

## ***EDITORIAL BOARD***

### ***FACULTY COORDINATORS***

**Dr. R. Sankerganesh, ASP/EEE,**

**Mr. P. Manikandan, AP/EEE,**

### ***STUDENT COORDINATORS***

**73152314047- SARIKA P, III EEE**

**73152314049- SHREENITHI G, III EEE**

**73152314048- SHIVARANJAN K, III EEE**

## VISION OF THE DEPARTMENT

To produce competent Electrical and Electronics Engineers driving sustainable solutions through quality education and research.

## MISSION OF THE DEPARTMENT

**DM 1:** Provide transformative education in Electrical and Electronics Engineering by integrating modern pedagogy and technology-enhanced learning.

**DM2:** Deliver holistic, value-driven education through cutting-edge laboratory facilities that meet the evolving needs of global industries.

**DM3:** Promote collaborative and interdisciplinary research to develop sustainable solutions.



## DEPARTMENT PROFILE

The Department of Electrical and Electronics Engineering (EEE) was started in the year 2002 with an intake of 60 students. Over the years the Department has steadily grown and currently the student's intake is 60. Along with B.E., the Department also offers a one M.E., degree Programme in Power Electronics & Drives. Choice based credit system is introduced in regulation 2018.

The Department has been accredited by the National Board of Accreditation (NBA), New Delhi. The Department has good infrastructure with well-equipped laboratories and an exclusive Departmental library.

## PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

### PEO 1:

**Core Competency:** Graduates will exhibit strong technical knowledge in Electrical and Electronics Engineering to analyze, design and develop sustainable engineering solutions.

### PEO 2:

**Professionalism:** Graduates will integrate interdisciplinary knowledge and ethical responsibility to develop innovative solutions addressing societal challenges.

### PEO 3:

**Career Development:** Graduates will engage in lifelong learning and research for sustainable development to meet the evolving needs of the industry.

## PROGRAM OUTCOMES (POS)

**PO1: Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

**PO2: Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

**PO3: Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

**PO4: Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

**PO5: Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

**PO6: The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

**PO7: Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

**PO8: Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

**PO9: Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.

**PO10: Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

**PO11: Life-Long Learning:** Recognize the need for and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

## PROGRAM SPECIFIC OUTCOMES (PSOS)

### PSO 1:

**Power and Energy Systems:** Design, operate, maintain efficient and sustainable electrical power systems with renewable energy integration.

### PSO 2:

**Embedded System and Automation:** Develop embedded, real-time control systems, and power electronic solutions for industrial process automation.



## ENGINEERING MADE SIMPLE! (Understand the Basics of the Components)

**V.ABISHEK**  
**III - EEE**

**S. SANTHOSH**  
**III - EEE**

### ARDUINO UNO:

Arduino is an open-source hardware and software company, project and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world.



Starting clockwise from the top centre:

- Analog Reference pin (orange)
- Digital Ground (light green)
- Digital Pins 2-13 (green)



Digital Pins 0-1/Serial In/Out -TX/ RX (dark green) – These pins cannot be used for digital I/O (digital Read and digital Write) if you are also using serial communication (e.g. Serial.Begin).



- Reset Button - S1 (dark blue) In-circuit Serial Programmer (blue green)
- Analog In Pins 0-5 (light blue)
- Power and Ground Pins (power: orange, grounds: light orange) External Power Supply In (9-12VDC) - X1 (pink)
- Toggles External Power and USB Power (place jumper on two pins closest to desired supply) -
- SV1 (purple)
- USB (used for uploading sketches to the board and for serial communication between the board and the computer; can be used to power the board) (yellow)

### Advantages:

- ✦ Inexpensive
- ✦ Cross-platform
- ✦ Simple, clear programming environment
- ✦ Open source and extensible software

### RASPBERRY PI:

A small and affordable computer that you can use. The Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote teaching of basic computer science in schools and in developing countries.



Two 5V pins and two 3V3 pins are present on the board, as well as a number of ground pins (0V), which are unconfigurable. The remaining pins are all general purpose 3V3 pins, meaning Outputs are set to 3V3 and inputs are 3V3-tolerant.

### Outputs:

A GPIO pin designated as an output pin can be set to high (3V3) or low (0V).

### Inputs:

A GPIO pin designated as an input pin can be read as high (3V3) or low (0V). This is made easier with the use of

internal pull-up or pull-down resistors. Pins GPIO2 and GPIO3 have fixed pull-up resistors, but for other pins this can be configured in software.

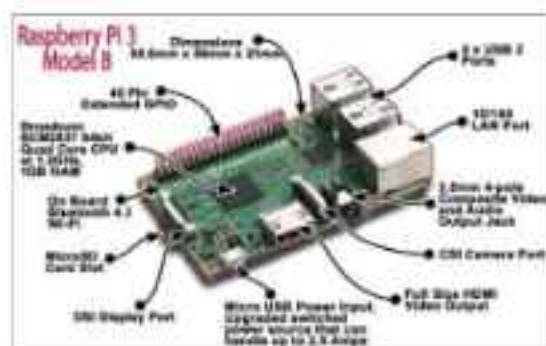
As well as simple input and output devices, the GPIO pins can be used with a variety of

### SPI:

- ✓ SPI0: MOSI (GPIO10); MISO (GPIO9); SCLK (GPIO11); CE0 (GPIO8); CE1 (GPIO7)
- ✓ SPI1: MOSI (GPIO20); MISO (GPIO19); SCLK (GPIO21); CE0 (GPIO18); CE1 (GPIO17); CE2 (GPIO16)

### I2C:

- Data: (GPIO2); Clock (GPIO3)
- EEPROM Data: (GPIO0); EEPROM Clock (GPIO1)



### Serial:

- TX (GPIO14); RX (GPIO15)

### Applications:

- Home Automation System
- Miniature Camcorder
- Zero-Powered Smartphone
- Xbox Zero
- AI Assistant
- Wireless Print Server
- Motion Capture Security Camera

♦ ♦ ♦ ♦

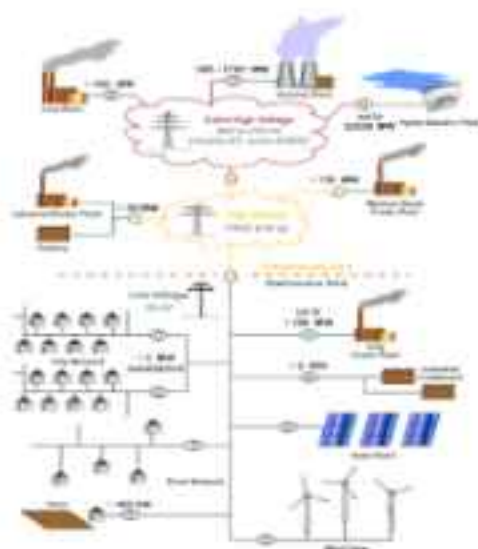
## IMPACT OF ELECTRICAL ENGINEERING IN DIGITALIZATION

P.KRISHAVENI  
III-EEE

M.AISWARYA  
III-EEE

### Introduction:

Today's world is world of high technology starting from most complex rocket science including AI robots. The technical world is dominating the human. Our country India which is developing country is digitalization in the Sector of electrical machinery, electronic manufacturing, high speed internet, broadband highway etc.



The electrification of Indian rail network was increasing day by day and In future we have high speed bullet train which get more electricity to run in high speed,

The electrification of airports in India was also increasing day by day and in future we have more airports to run this airport in

future we want more electricity. In India the vehicles are increasing day by day which

need more petrol or diesel to run but in future we do not have more petrol or diesel to run. To short out this problem In future we have another good technology that is **ELECTRIC CAR** which needs electricity to run, In future we have **ROBOTS** and there also we need electricity and In India the quantity of homes, buildings, and hospitals, super markets etc are increasing where we need more electricity. In this all field the hand of "**ELECTRICAL ENGINEERING**" is **INVALUABLE**.



Electrical Engineering is the main force behind the digital India, make in India and the power ministry focus on three things one is the village electrification, second one is household electrification and umbrella program for 24x7 power supply.

For the continuous supply of power to the smart cities, rails networks, airports, etc. is



very essential to have strong and smart transmission and distribution systems.

The electrical machinery industry contributes massively to the capital goods sector of India and the electrical machinery industry holds about 69% share in the capital goods industry.

The Indian government has started "MAKE IN INDIA" plan and it is a way ahead. MAKE IN INDIA was launched in 25 September 2014 with objective of job

creation, skill enhancement and transform India into global design and manufacturing hub.

Now India is the 4th largest wind power capacity in the world and its capacity stands at 34 GW, 6th largest solar power capacity in the world and its capacity stands at 22 GW and 7th largest producer of hydroelectric power in the world and its capacity at 44,594 MW Biomass power is the installed in India which produces 8.1 GW power as in November 2017.

The total power generation in India is 70 GW in 2017-2018.

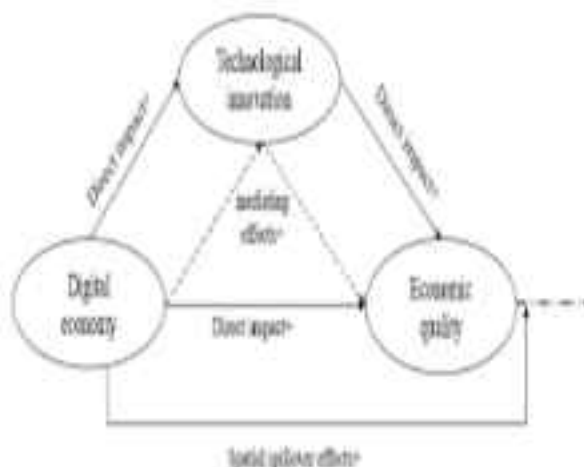
The Indian government has set target of adding 175 GW power in the country by 2022!!

After the surveying of all this above information we found that In future **ELECTRICAL ENGINEERING** is much more helpful for **MAKE IN INDIA** AND **DIGITAL INDIA** POGRAM.

#### Conclusion:

As a result, electrical engineers have made significant contributions to society and improved our quality of life. Electrical engineers contribute to the generation of energy from power plants, contributions to medicine and biology, contributions to telecommunications, and contributions to computer systems.

\*\*\*\*\*



## SMART CARD

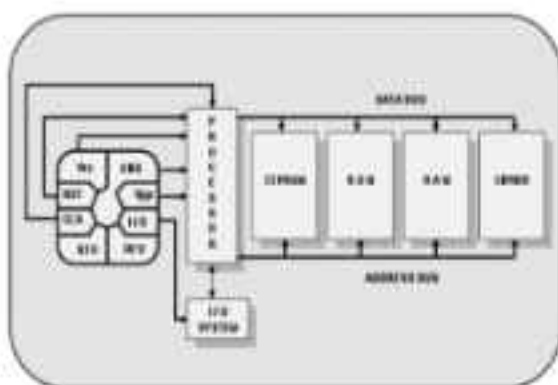
**P. MOHANAPRIYA**  
III-EEE

**G.SUDHARSHAN**  
III-EEE

### What is a Smart Card?

A smart card is a special type of card like device which contains an integrated circuit chip embedded on it. The IC chip can be a microprocessor with memory or just simple memory circuit. In simple layman's words, a smart card is the card with which we can exchange the data, store it and manipulate data.

Smart cards are designed to be tamper-resistant and use encryption to provide protection for in-memory information. Cards with microcontroller chips can perform on-card processing functions and manipulate information in the chip's memory.

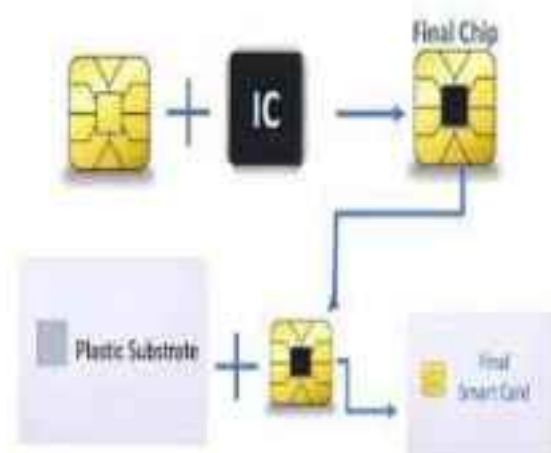


### How does the Smart Card Works?

A smart card is connected to the host computer or controller via a card reader which gets information from the smart card and accordingly passes the information to the host computer or controller.

### What is a Smart Card Reader?

A smart card reader is a device to which the smart card is connected either directly or indirectly using RF communication. It



interfaces with the PC or a microcontroller using USB port or RS232 serial ports. It can be a contact or contactless reader.

### Types of Smart Card based on Connection to the Smart Card Reader

**Contact Smart Card:** This type of smart card consists of electrical contacts which are used to connect to the card reader where the card is inserted. The electrical contacts are deployed on a conductive gold-plated coating on the card surface. A Contact Smart Card with Electrical Connections

**Contactless Smart Card:** This type of smart card communicates with the reader without any physical contact. Rather it consists of an antenna with which it is used to communicate

using Radio Frequency band with the antenna on the reader. It usually receives power from the reader via the electromagnetic signal.

Types of Smart Cards based on their Functionalities and Configuration

**Memory Cards:** These are cards which only consist of memory circuits. It can only store, read and write data to a particular location. The data cannot be processed or manipulated. It can be a straight memory card which is only used to store data or a protected memory card with a restricted access to the memory and which can be used to write data. It can also be a rechargeable or a disposable card which contains memory units which can be used only once.



#### Memory Smart Card

**Microprocessor Based Cards:** These cards consist of microprocessor embedded onto the chip in addition to the memory blocks. It also consists of specific sections of files with each file associated with a particular function. The data in files and the memory allocation is managed via an operating system which can be a fixed operating system or dynamic operating system. It allows for data processing and manipulations and can be used for multi-functioning.

#### Steps to Construct a Smart Card:

- The first step involves designing. The designing involves specifying the chip for the memory size, clock speed, volatile memory types, type of operating system and specifying the application software, specifying the card type, size and functioning and additional features.
- The second step involves chip fabrication. This involves mounting the silicon chip on an epoxy glass substrate with gold plated connectors, using a die. The silicon chip is bonded to the connectors using connecting wires (wire bonding technique) or using flip chip technology (using a solder). The chip on board substrate is then sealed using epoxy resin and glued to the card substrate. The card substrate can be PVC based plastic card or Polyester based card.
- The third step involves loading the code to the memory using special commands.
- The fourth step involves data loading into the PROM memory such that the data pertains to the single person.

#### Advantages of Smart Card:

- ✓ Might be promptly reconfigured
- ✓ Reusable
- ✓ Secure transactions
- ✓ Gives more security
- ✓ More tough and dependable
- ✓ Permit numerous provisions to be saved in one card

## **Smart Card Applications:**

**Telecommunications:** The most prominent use of smart card technology is in the development of SIM card or Subscriber Identity Module. A SIM card provides unique identification to each subscriber and provides network access to each subscriber and manages its authentication.

**Domestic:** The most frequently used smart card in domestic field is the DTH smart card. This card provides authorized access to the information coming from the satellites. In simple words the card with which we can get access to the Direct to Home TV services is nothing but a smart card. The information is encrypted and decrypted within a smart card.

**Ecommerce and Retail:** Smart card can be used to store information like a person's account details.

## **Benefits:**

The benefits of smart cards are directly related to the volume of information and applications that are programmed for use on a card. A single contact/contactless smart card can be programmed with multiple banking credentials, medical entitlement, driver's license/public transport entitlement,

loyalty programs and club memberships to name just a few. Multi-factor and proximity authentication can and has been embedded into smart cards to increase the security of all services on the card. For example, a smart card can be programmed to only allow a contactless transaction if it is also within range of another device like a uniquely paired mobile phone. This can significantly increase the security of the smart card.

Governments and regional authorities save money because of improved security, better data and reduced processing costs. These savings help reduce public budgets or enhance public services. There are many examples in the UK, many using a common open Lasse specification.

Individuals have better security and more convenience with using smart cards that perform multiple services. For example, they only need to replace one card if their wallet is lost or stolen. The data storage on a card can reduce duplication, and even provide emergency medical information.

\*\*\*\*

## POWER LOSSES

M.K.TAMILSELVAN  
III-EEE

S.THIBISH  
III-EEE

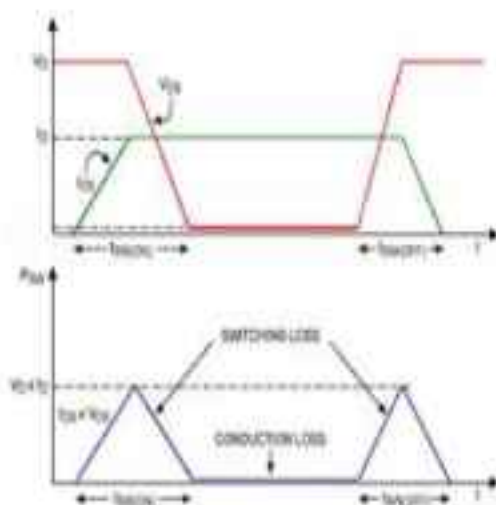
### Introduction:

The electrical transmission and distribution losses accounts for most of the power losses in the entire system.

The largest amounts of these losses occur in the primary and secondary distribution lines, and can be classified as either technical losses or non-technical losses.

### Technical electrical power losses:

Technical losses occur when the energy is dissipated by the equipment and conductors in the distribution lines. The losses depend on the network characteristics, and mode of operation. There are two categories of technical power losses; the fixed technical losses and the variable technical losses.



### Fixed Technical Losses:

The fixed losses in the distribution lines account for between a quarter and a third of the total technical losses. These are usually in the form of heat and noise and

occur whenever the transformer is energized.

The fixed losses are not influenced by the amount of load current flowing, but rather by the leakage current losses

- Open circuit losses
- Corona losses
- Dielectric losses

### Variable Technical Losses:

The variable losses are proportional to the square of the load current and accounts to between 2/3 and 3/4 of the technical losses in a distribution system. The variable losses arise due to the line impedance, contact resistance and the joule heating losses.

### Causes of Technical Losses:

Inefficient equipment such as the transformers, pumps, electrical machines, and industrial loads.

- Inadequate size of conductor in the distribution lines
- Long distribution lines
- Load imbalance among the phases
- Low power factor.
- Over loading of lines
- Transformers installed far from the load centers
- Haphazard installation of distribution systems to cope with demands to new areas
- Bad workmanship

### Commercial Power Losses:

The non-technical losses, also referred to as commercial losses, are those related to unmetered supplies,

incorrect billing, untimely billing, wrong tariff, defective meters, and energy thefts.

The unmetered supplies are those that may be left out when estimated amounts are used to calculate the

amount of power to bill for. In addition, some consumers may tamper with the meters to make them indicate less power than what is actually used. The energy theft may occur when consumers tamper with the metering, or collude with the utility personnel to make illegal connections.

### Analysis of Loss Reduction Initiatives :

Following analysis are performed on the various loss reduction initiatives –

1. Type 1 Analysis – Overall Analysis of Loss Reduction initiatives included, classifying initiatives in 4 broad categories based on the number of states adopted for the same.

2. Type 2 Analysis – State Specific analysis included analysis to map types of initiatives against type of losses they are effective in reducing.

Type 1 Analysis – Overall Analysis of Loss Reduction:

Depending on the number of states has adopted a particular initiative, an analysis has been done and initiatives are classified into four categories:

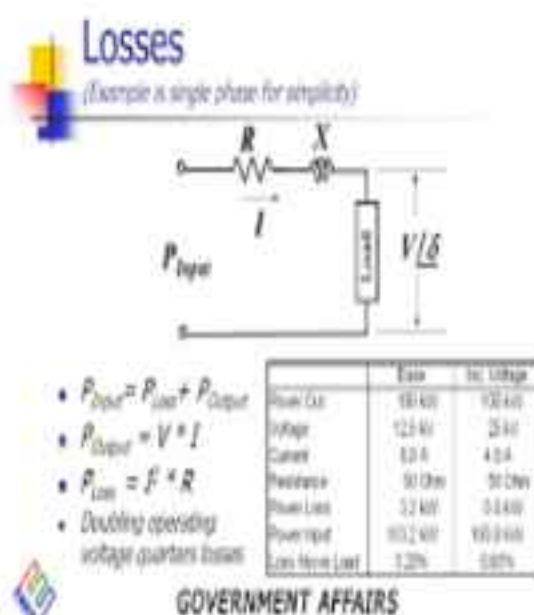
- I. Must have Initiatives: Initiatives adopted by 8 or more utilities out of 10 selected utilities.

- II. Strongly desirable initiatives: Initiatives adopted by 5 to 7 utilities out of 10 selected utilities.

- III. Good to have initiatives: Initiatives adopted by 3-4 utilities out of 10 selected utilities.

- IV. Other initiatives: Initiatives adopted by 2 or less no. of utilities out of 10 selected utilities.

Type 2 Analysis - State Specific analysis:



### Development of Loss Reduction Strategy:

To develop a loss reduction strategy, the following framework can be adopted -

Measurement of loss - Various types of losses can be measured as follows:

Technical Loss = Energy input in the Discom periphery – Energy Consumed in the Distribution

Network, or Technical Loss = [Energy input at the discom periphery – (DT level consumption + sum of sales to consumer on HT)] – LT technical loss

Non-Technical Loss (occurring due to incorrect energy accounting) = Energy Consumed in them Distribution Network – Energy billed to consumers, or non-technical loss (occurring due to incorrect energy accounting) = Energy input in the Discom periphery – (technical loss + energy sales)



Non-Technical Loss (occurring due to non-recovery) = Energy billed to consumers – Energy collected from consumers, or Non-technical loss (occurring due to non-recovery) =  $100\% - [\text{billing efficiency}(\%) * \text{collection Efficiency}(\%)]$  Where  $\text{billing efficiency} = 100 - \text{distribution losses}(\%)$ .

#### **How to reduce power losses in distribution lines?**

Losses in the distribution of electricity cannot be eliminated, but can be minimized by proper planning of the distribution systems to ensure that power remain within limits. Some of the ways to reduce losses Use of proper jointing

techniques, and keeping the number of the joints to a minimum.

Regular inspection of the connections, isolators, drop out fuses, LT switches, transformers, transformer bushing-stem, and other distribution equipment.

Proper selection of conductor size, as well as the transformer in terms of efficiency, size, and location. It is important to locate the distribution transformers at the load center and if possible, keep the number to a minimum.

Feeding heavy consumers directly from the feeders.

Maintain the network components and replace those that are deteriorating, worn out or faulty.

Proper load management and load balancing

Use of electronic meters which are accurate and tamper-proof.

Improving power factor by adding shunt capacitors.

#### **Summary:**

Power losses in an electrical distribution network can be minimized by proper planning and designing of the lines, use of efficient equipment at both the distribution and consumer levels. In addition, there should be periodic maintenance, and replacing of malfunctioning and energy inefficient distribution equipment and parts.

\*\*\*\*\*

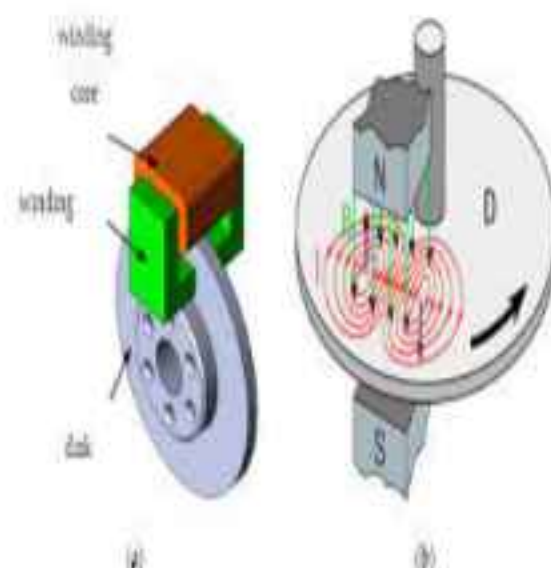
## EDDY CURRENT BRAKE

D.PAVITHRA  
III-EEE

S.TAMILARASAN  
III-EEE

### Need For It:

Many of the ordinary brakes, which are being used now a days to stop the vehicle by means of mechanical blocking. This causes skidding and wears & tears of the vehicle and if speed of the vehicle is very high, the brake can't provide that much high braking force & it will cause problem. These drawbacks of ordinary brakes can be overcome by "The Eddy current brake".



### Principle Of Operations:

It works according to Faraday's law of electromagnetic induction. Essentially the Eddy current brake consists of two parts, a stationary magnetic field system and a solid rotating part, which include a metal disc. During braking the metal disc is exposed to a magnetic field from an electromagnet, generating Eddy currents in the disc. The magnet interaction between the applied field and the Eddy currents slows down the rotating disc. Thus, the

wheels of the vehicle also slow down since the wheels are directly coupled to the disc of the Eddy current brake, thus producing smooth stopping motion.

### Types:

It is of two types

- 1- Electrically excited eddy current brake
- 2- Permanent magnetic eddy current brake

### Electrically Excited Eddy Current Brake:

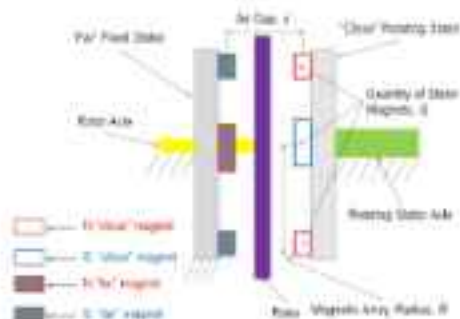
Electrically excited eddy current brakes are a friction-free method for braking. In high-speed trains they offer a good alternative to the mechanical rail brakes which are being used now a-days. During braking, the brake meets the rail, and the magnetic poles of brakes are energized by a winding supplied. Magnetic poles of brakes are energized by a winding supplied with current from the battery.

Then the magnetic flux is distributed over the rail. The eddy currents are generated in the rail, producing an electromagnetic braking force. These types of braking need an additional safety power supply when there are breakdowns in the electrical power supply.

The maximum diameter of the Eddy current brake is decided by

- 1- The spacing of vehicle chassis frame
- 2- Vehicle floor clearance

In this braking system kinetic energy of the vehicle is converted to heat and this heat is dissipated through the rotating disc.



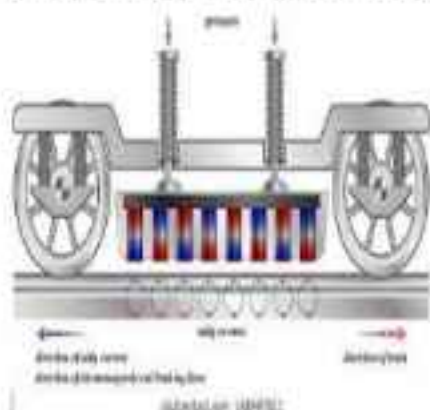
### Working:

When the vehicle is moving, the rotor disc of eddy current brake which is coupled to the wheels of the vehicle rotates, near stationary magnetic poles. When we want to brake the vehicle, a control switch is put on which is placed on the steering column in a position for easy operation.

Due to Lenz's law, the magnetic field produced by the eddy currents works against the movement direction. Thus instead of mechanical friction, a magnetic friction is created. In consequence, the disc will experience a "drag" or the braking effect, and thus the disc stops rotation.

The control switch can be set at different positions for controlling the excitation current to several set values in order to regulate the magnetic flux and consequently the magnitude of braking force. i.e. if the speed of the vehicle is low, a low braking force is required to stop the vehicle. So, the control switch is set at the lowest position so that a low current will be supplied to the field winding. Then the magnetic field produced will be of low strength, so that a required low braking force is produced.

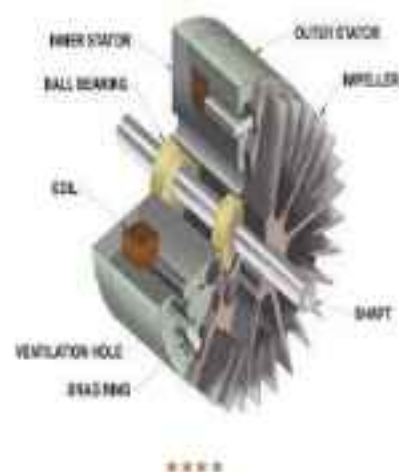
The magnetic field of this eddy current produces a braking force or torque in the opposite direction of rotation disc. This kinetic energy of rotor is converted as heat energy and dissipated from rotating disc to surrounding atmosphere. Current in the field can change by changing the position of the controls switch. Thus, we



can change the strength of the braking force.

### Application:

In case of TRAINS, the part in which the current is induced is rail. Brake shoe is enclosed in a coil from an electromagnet, when the magnet is energized, Eddy current are induced in the rail by means of an electromagnetic induction probably producing braking action.



## ROBO PETS

**HARISH P  
II-EEE**

**DEEPAK RAJ M  
II-EEE**

### **Introduction:**

Pets are often lovable companions that bring joy to their respective owners. However, one of the inconveniences of pet ownership is the constant support that pets require as most are not self-sufficient. For those seeking a pet companion but not the responsibilities a robotic pet may be a option. While the major benefit of a live pet is the unwavering companionship, robotic pets have nice benefits.



### **Fewer Responsibilities:**

Unlike a real pet, there is no need to continually refill the water and food bowls. Better yet, there are no sad, puppy-dog eyes seeking food off the dinner table. As there is no need to feed the robotic pet, there is also no dealing with any after-dinner walks. And there's the benefit of a home free of the odors associated with those bodily functions. Live animals, especially dogs, get dirty, can smell, and need a bath. However, with a robotic pet, none of that is required.

### **Robotic Pets won't be a "Bad" Pet:**

Real pets, especially those that are not trained, may chew on or damage furniture or other property. Animals may also bite those who feed, pet, or attempt to play with them. A live pet may make unwanted or excessive noises, such as loud barking from a dog or continuous chirping from a bird. (Time to call a trainer ) On the other hand, a robotic pet's actions are always controllable. Less in the Long Run.

The price of a robotic pet will vary and the same is true for the price of a live pet as it would apply to the pet's breed, heritage, and consumer market. However, robotic pets will cost less in the long run as most of the expenses will be absorbed in the initial purchase, given that only batteries or electricity for recharging will need to be purchased in the future.

The cost of a live pet becomes more expensive over time as an owner will continually have to purchase food, toys, and health care.

### **Robotic Pets Are Convenient:**

Some studies have shown that robotic pets are just as beneficial in preventing loneliness particularly among the senior population. Robotic-pet owners have full control over their pet and can initiate attention and playtime because a robotic pet can be turned off.

The absence of support required when an owner leaves the home or goes on vacation is another consideration.

#### **Robotic Pets Do Things Live Pets Can't:**

Robots are programmed to perform certain functions, such as to communicate with the owner. Some highly-advanced robotic pets can be trained by the owner. If the owner prefers a pet that has the excitement of a new puppy, that is a behavioral option for the robotic pet allowing an owner to indefinitely have a puppy.



Robotic pets will vary in technological capabilities, but robotic pets will only get better as technology continues to advance. A simple robotic pet may be stationary and have limited actions, typically facial movements such as closing and opening the eyes and mouth. While robotic pets may not fulfil the real-life aspect desired by some, the pets certainly do have their own advantages. Some of the benefits are directly the opposite of the negatives associated with a live pet, which

will greatly appeal to some prospective owners. It will ultimately be a personal choice, but don't forget: Having one doesn't mean not having the other. Owning both is always a possibility, and an owner's live pet will possibly enjoy playing with the robotic pet too.



#### **Conclusion:**

At last, we can see that a robotic pet can also speak, whereas only few birds can accomplish that feat; but who wants to carry on a conversation with their cat.

A robotic dog will not bite or scratch your robotic pet technology will soon be sophisticated enough to cover our emotional needs robotic dogs, for instance, will have social intelligence, providing what people need from their dogs, such as companionship, love, obedience, dependence etc. just because you have a robotic pet doesn't mean that you couldn't also have a live pet as well. Possessing both is always a prospect benefit from playing with the robotic pet as well.

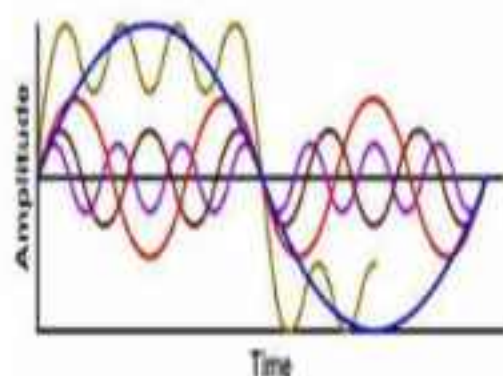
\*\*\*\*\*

**NAVEEN KUMAR K**  
IV-EEE

**MAREESWARAN P**  
IV-EEE

## Harmonics:

Harmonics are electric voltages and currents on an electric power system that can cause power quality problems. Harmonics are created by electronic equipment with nonlinear loads drawing in current in abrupt short pulses. The short pulses cause distorted current waveforms, which in turn cause harmonic currents to flow back into other parts of the power system.



## Problems Caused by Harmonics:

### 1. Overloading neutral conductor

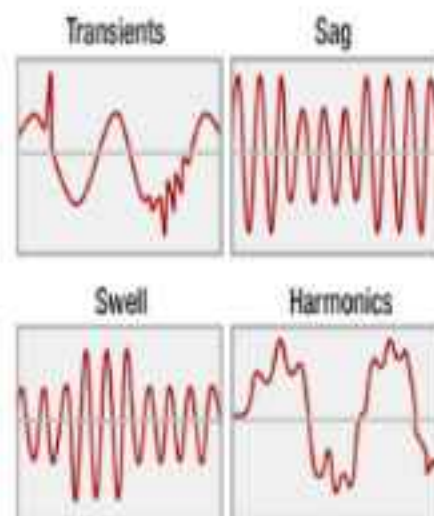
The three-phase system consists of three individual phase conductors and a neutral conductor. If all the phase

conductors carry the same current, the phase currents tend to cancel one another out provided there is a balanced load. This

balanced load makes it possible to reduce the size of the neutral conductor. Unfortunately, switched mode power supplies used in computers have a very high third-harmonic current. While harmonic currents cancel out on the neutral wire, the third harmonic current is additive in the neutral. In buildings with many installed personal computers, the neutral wire can carry much higher currents than the wire was designed to accommodate, creating a potential fire hazard.

### 2. Overheating Transformers and Increased Associated Losses

For transformers feeding harmonic-producing loads, the eddy current loss in the windings is the most dominant loss component in the transformer. This eddy current loss increases proportionate to the square of the product's harmonic current and its corresponding frequency. The total transformer loss to a fully loaded transformer supplying to a nonlinear load is twice as high as for an equivalent linear load. This causes excessive transformer



heating and degrades the insulation materials in the transformer, which eventually leads to transformer failure.

### 3. Nuisance Tripping of Circuit Breakers

All circuits containing capacitance and inductance have one or more resonant frequencies. When any of the resonant frequencies correspond to the harmonic frequency produced by nonlinear loads, harmonic resonance can occur. Voltage and current during resonant frequency can be

#### How The Harmonics Can Be Reduced:

#### 1. Reducing Harmonic Currents in Loads

There is often little that can be done with existing load equipment to significantly reduce the amount of harmonic current it is producing unless it is being mis-operated.

PWM drives that charge the dc bus capacitor directly from the line without any intentional impedance are one exception to this. Adding a line reactor or transformer in series will significantly reduce harmonics, as well as provide transient protection benefits.

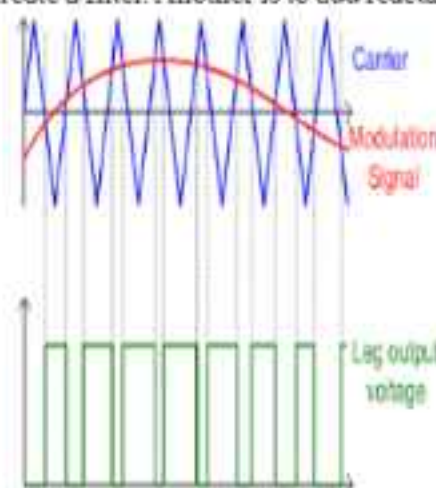
#### 2. Filtering

The shunt filter works by short circuiting harmonic currents as close to the source of distortion as practical. This keeps the currents out of the supply system. This is the most common type of filtering applied because of economics and because it also tends to correct the load power factor as well as remove the harmonic current.

#### 3. Modifying the System Frequency Response

There are number of methods to modify the frequency response of the system:

Add a reactor to detune the system. Harmful resonances generally occur between the system inductance and shunt power factor correction capacitors. The reactor must be added between the capacitor and the supply system source. One method is to simply put a reactor in series with the capacitor to move the system resonance without tuning the capacitor to create a filter. Another is to add reactance in the



line.

Change the capacitor size. This is often one of the least expensive options for both utilities and industrial customers. This is also an option for utilities when a new bank causes telephone interference moving the bank to another branch of the feeder may very well resolve the problem.

Remove the capacitor and simply accept the higher losses, lower voltage, and power factor penalty. If technically feasible, this is occasionally the best economic choice. By using these methods, we can eliminate harmonics in a proper manner.

\*\*\*\*\*

## PLC - PROGRAMMABLE LOGIC CONTROLLER

MANIKANDESWARAN  
III-EEE

A PRIYADHARSHINI N  
III-EEE

### Introduction:

Programmable Logic Controller (PLC) is a special computer device used in industrial control systems. Due to its robust construction, exceptional functional features like sequential control, counters and timers, ease of programming, reliable controlling capabilities and ease of hardware usage – this PLC is used as more than a special-purpose digital computer in industries as well as in other control-system areas. Most of the industries abbreviate these devices as “PC” but it is also used for personal computers; due to this, many manufacturers named these devices as PLCs.

The programmable logic controller is used not only for industrial purpose but also in civil applications such as washing machine, elevators working and traffic signals control. Different types of PLCs from a vast number of manufacturers are available in today's market. Therefore, in the following paragraphs, let us study about programmable logic controller's basics, principles, and applications.

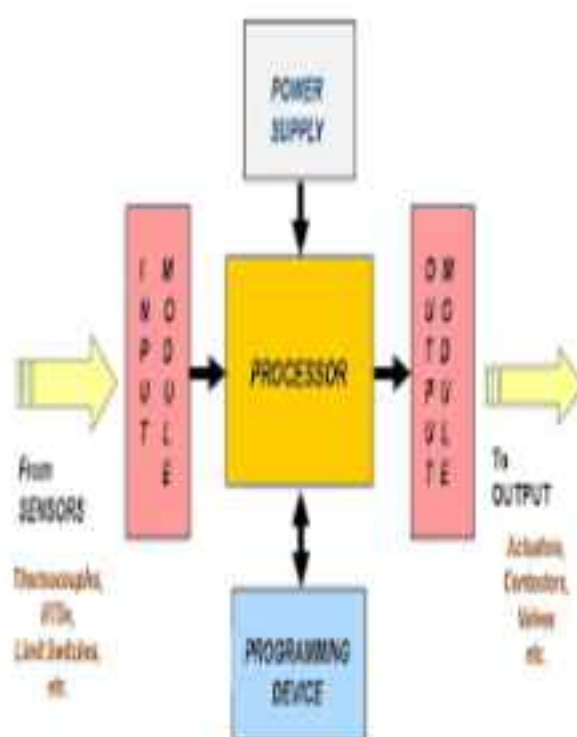
### Principle of Programmable Logic Controller:

A programmable logic controller is used for continuously monitoring the input values from sensors and produces the outputs for the operation of actuators based on the program. Every PLC system comprises these three modules:

- ✓ CPU module
- ✓ Power supply module
- ✓ One or more I/O module
- ✓ PLC Architecture

### CPU Module:

A CPU module consists of central processor and its memory. The processor is responsible for performing all the necessary computations and processing of data by accepting the inputs and producing the appropriate outputs.



### Power Supply Module:

This module supplies the required power to the whole system by converting the available AC power to DC power required for the CPU and I/O modules. The 5V DC output drives the computer circuitry.

### I/O Modules:

The input and out modules of the programmable logic controller are used to connect the sensors and

actuators to the system to sense the various parameters such as temperature, pressure, and flow, etc.

These I/O modules are of two types: digital or analog.

### Communication Interface Modules:

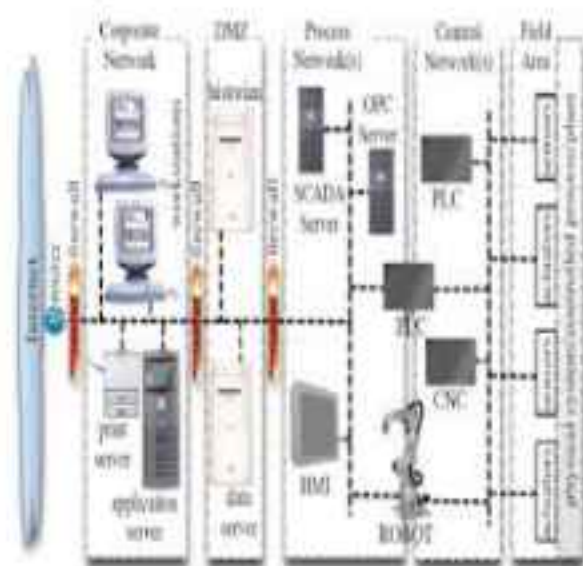
These are intelligent I/O modules which transfers the information between a CPU and communication network. These communication modules are used for communicating with other PLC's and computers, which are placed at remote place or far-off locate. The program in the CPU of programmable logic controller consists of operating system and user programs. The purpose of the operating system with CPU is to deal with the tasks and operations of the PLC such as starting and stopping operations, storage area and communication management, etc. A user program is used by the user for finishing and controlling the tasks in automation. The Principle of operation of the PLC can be understood with the cyclic scanning also called as scan cycle, which is given in the below figure.

### Applications of Programmable Logic Controller (PLC):

The PLC can be used in industrial departments of all the developed countries in industries like chemical industry, automobile industry, steel industry and electricity industry. Based on the development of all these technologies, functionality and application, the scope of the PLC increases dramatically.

#### 1. Application of PLC in Glass Industry

From the year 1980 the Programmable-logic controllers are in use in the glass industry, and they are assembled bit by bit. PLCs are used mainly in every procedure and workshop for controlling the material ratio, processing of flat glasses, etc. With the development of PLC and increasing demand in the real world, the control mode of the programmable-logic controller with an intelligent device is applied in the glass industry.



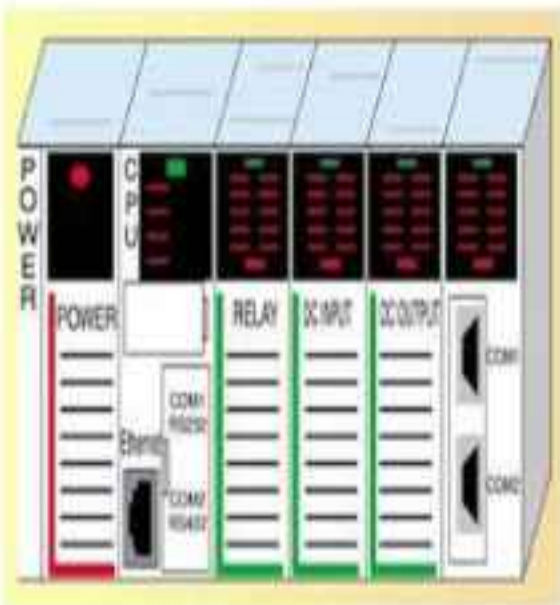
In making of a float glass, PLC itself cannot finish some controlling tasks because of the complexity of the control system and

processing of huge data. To produce glass, we make use of bus technology to construct the control mode of a PLC with a distributed-control system.

This control system deals with analogue controlling and data recording; the PLC is also used for digital quality control and position control. This type of control mode is a big advantage for PLC and DCS for improving reliability and flexibility of the control system.

## 2. Applications of PLC in Cement Industry

Along with the best-quality raw



materials, the accurate data regarding process variables, especially during mixing processes within the kiln, ensures that the output provided should be of the best possible quality. Nowadays a DCS with bus technology is used in the production and

management industry. By using this existing DCS control system, the PLC is in user mode of SCADA. This mode comprises PLC and configuration software. This SCADA mode comprises the PLC and host computer. The host computer consists of slave and master station. The PLC is used for controlling the ball milling, shaft kiln and Kiln of coal.



The principle of operation of programmable logic devices or controller and its applications in various industries like glass industry, steel industry and cement industry

\*\*\*\*\*

# SOLAR PHOTOVOLTAIC MAXIMUM POWER POINT TRACKING

**PARTHIPAN A**  
III-EEE

**GUNALAN K P**  
III-EEE

## Introduction:

PHOTOVOLTAIC power is an established technology and has recently experienced rapid growth over the last twenty years. The maximum power point tracking (MPPT) is the automatic control algorithm to adjust the power interfaces and achieve the greatest possible power harvest, during moment-to-moment variations of light level, shading, temperature, and photovoltaic module characteristics. It has become an essential component to evaluate the design performance of photovoltaic power systems.



In recent years, many publications give various solutions to the problem of maximum power point tracking for photovoltaic power systems. In 2006, the review study has summarized various MPPT techniques and has presented valuable comparisons between them. To continue the literal chronology, focuses more on the implementation topology and the latest

MPPT techniques with a brief discussion and classification, which can be useful as a reference for future research. Maximum Power Point Tracking algorithms (MPPT) are used to track maximum power, a DC-DC Boost converter is used to obtain the impedance matching between the PV array and the load. Although a huge number of approaches have been proposed in literature, the methods based on the perturb and observe (P&O) technique are the most widely employed in commercial products. The reason lies in the fact that P&O can be implemented in cheap digital devices by ensuring high robustness and a good MPPT efficiency.

The design and development of a photovoltaic system based on the enhanced P&O algorithm that allows improving efficiency, stability, and accuracy of solar systems. The effectiveness of the proposed solar regulator system is verified by the simulation by Power Sim simulator and experimental results under our developed system using two MPPT algorithms, classical P&O, and a new enhanced P&O algorithm.

## DC-DC Converter Analysis:

DC/DC Converters are most widely applied in photovoltaic systems as an intermediary between the PV and the load to follow up the maximum power point (MPP). Different topologies and different design approaches could be used for DC/DC converters. In this part two different models of converters are introduced, buck and boost converters.

### A. Buck Converter:

The buck converter is known as the voltage step down and current step-up converter. This gives a hint of its typical application of converting its input voltage into a lower output voltage, where the conversion ratio  $M = V_{out}/V_{in}$  varies with the duty ratio  $D$  of the switch. The state space equation of buck converter is as follows:

$$\frac{dI_L}{dt} = -\frac{1}{L}V_0 + \frac{d}{L}V_{pv}$$

### B. Boost Converter:

The boost converter is also known as the step-up converter. The name implies its typically application of converting a low input-voltage to a high output voltage, essentially functioning like a reversed buck converter. The state space equation of boost converter is as follows:

$$dI_L/dt = -(1-d)/L \cdot V_0 + 1/L \cdot V_{pv} \quad (2)$$

### MPPT Technique:

As was previously said, MPPT algorithms are necessary in PV applications because the MPP of a solar panel varies with the irradiation and temperature, so the use of MPPT algorithm is required in order to obtain the maximum power from a solar array.

#### A. P&O Method:

The Perturb and Observe (P&O) method is one of the most used methods in practice. The P&O algorithms operate by periodically perturbing, i.e., incrementing or decrementing, the array terminal voltage and comparing the PV output power with that of the previous perturbation cycle. If

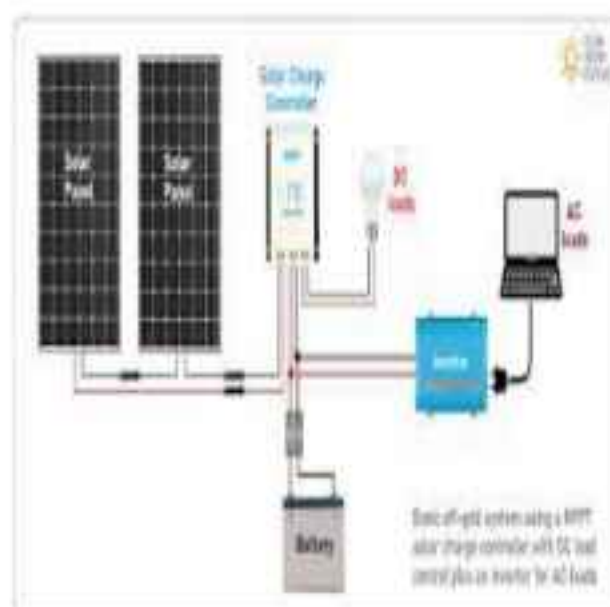
the PV array operating voltage changes and power increases, the control system moves the PV array operating point in that direction. Otherwise, the operating point is moved in the opposite direction. Figure demonstrates the principle of the P&O algorithm. The DC-DC controller adjusts slightly the voltage from the PV array and measures power, then it varies the terminal voltage of the PV and takes a second measurement of the power, if it increases, further adjustments in that direction are tried until power no longer increases



#### B. Enhanced P&O

The P&O algorithm is based on the "hill-climbing" principle, which consists of moving the operation point of the PV array in the direction in which the power increases are the most popular MPPT methods thanks to their ease of implementation and good performance when the irradiation is constant. The advantages of P&O method are the simplicity and low computational power they need. The drawbacks of this technique are mainly two, the main one is that they can easily lose track of the MPP if the irradiation changes rapidly. The other handicap of P&O method is the oscillations

of the voltage and current around the MPP in the steady state.



To overcome these drawbacks, we propose a new enhanced P&O. In this technique, the Maximum Power is calculated based on the measurements of the Irradiance and the Temperature using a model of the PV module. After calculating the max power, we run the classical P&O algorithm and after each complete execution cycle the difference between the current power (real power) and the power estimated at the beginning of the algorithm is calculated.

If the difference is zero, then we have reached the max power, so the present duty cycle value is the optimal control signal. This value is fixed and is taken as control signal for DC-DC boost converter until the next variation of the maximum power that PV can provide. The efficiency of the classical P&O algorithm tracking is improved by the new enhanced algorithm. This technique was simulated in power Sim, implemented, and tested using a complete system based on a microcontroller, a DC-DC boost converter,

a voltage and current sensors and a software application.

### C. Incremental Conductance Method:

This method uses two sensors for sensing voltage and current. The controller measures the incremental changes in the voltage and current, hence conductance of the array and predicts the effect of voltage change. Controller compares the changes in the incremental conductance and array conductance. When these two are same the array voltage is MPP voltage. The drawback of this method is that it loses track of MPP due to changes in the irradiation level.

### D. Fractional Open Circuit Voltage Method (FOCV)

The value of  $V_{mpp}$  is almost equal to  $V_{oc}$  under changing irradiance and temperature conditions, so it becomes easy to track MPP [18].  $V_{mpp}$  of a solar cell is given by equation (3),

$$V_{mpp} = K V_{oc} \quad (3)$$

The value of  $K$  lies between 0.71 to 0.78, and using the value of  $K$  and  $V_{oc}$ ,  $V_{mpp}$  can be easily determined.



### E. Fractional Short Circuit Current Method (FSCI)

In this method the FOCV method is considered in terms of current. Here, short

circuit current and current at MPP are related. The relation is given by equation (4),

$$I_{mpp} = KI_{sc} \quad (4)$$

It is difficult to measure  $I_{sc}$  during operation, so an additional switch is added to the converter to short PV array periodically and measure  $I_{sc}$ .

#### F. Fuzzy Logic Control:

Fuzzy logic control is a soft computing tool. This method consists of three stages: Fuzzification, rule base table and de-fuzzification. The advantage of this method is that it can work with imprecise and vague inputs and is able to handle non-linearity.

#### Conclusion:

In this paper the increasing demand for renewable resources of energy has been

emphasized. Mathematical model for PV cell is explained and the need for MPPT to achieve maximum power output is presented with the help of diagram. It provides classification of various MPPT techniques, their advantages and disadvantages. An enhanced P&O algorithm has been proposed to improve the maximum power point tracking in PV systems. The proposed system offers powerful abilities which are: good tracking efficiency, high response, simple user interface, sophisticated control, high processing speed, real time monitoring and good control for the extracted power. This paper will serve as a reference paper for the future work in PV power generation.

\*\*\*\*\*

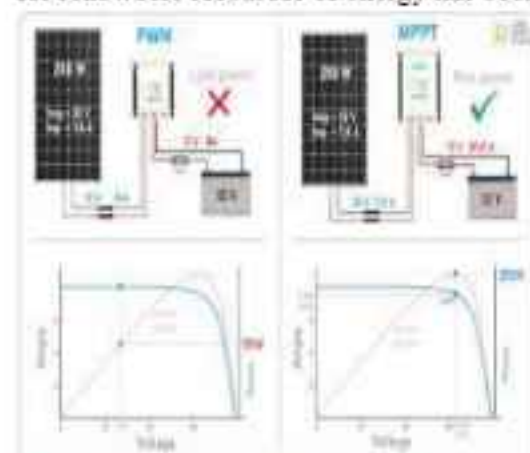


Fig. 1. Comparison of power extraction from a PV array using a fixed voltage and a MPPT.

## CIRCUIT BREAKER MAINTENANCE BY MOBILE AGENT SOFTWARE TECHNOLOGY

K. YUVARAJ  
III-EEE

P.SRIRAMPRASAD  
III-EEE

### Introduction:

Circuit breakers are crucial components for power system operations. They play an important role in switching for the routine network operation and protection of other devices in power systems. To ensure circuit breakers are in healthy condition, periodical inspection and preventive maintenance are typically performed.



New maintenance techniques and methodologies are emerging, while the circuit breakers keep improving in their designs and functions. As an example, some new circuit breakers have embedded monitoring instruments available to measure the coil current profiles and the operation timing.

The recorded information can be used to monitor the condition of breakers during each operation. In this case, it may be more appropriate to replace the time-directed maintenance by condition-directed maintenance practice. Since the number of

circuit breakers in a power system is usually very big, a small maintenance cost saving per each circuit breaker can accumulate to a considerable benefit for the whole system.

An Information access method that is capable of handling heterogeneous information sources will be helpful to achieve the above goal. Also, the new information access method should be secure and able to work on unreliable public networks. The mobile agent software provides a flexible framework for mobile agent applications. An agent application program can travel through the internet/intranet to the computers where the mobile agent server or transporter is running. The mobile agent software also supports Distributed Events, Agent Collaboration and Service Bridge. The mobile agent software may fit very well in the circuit breaker maintenance scenario. In this paper, we considered how mobile agent software might be applied in circuit breaker maintenance and monitoring from the viewpoint of the maintenance crew.

### Circuit Breaker Maintenance Tasks:

The maintenance of circuit breakers deserves special consideration because of their importance for equipment destruction can occur if a circuit breaker fails to operate because of a lack of a preventive maintenance. The need for maintenance of circuit breaker is often not obvious as

circuit breakers may remain idle, either open or closed, for long periods of time. Breakers that remain idle for six months or more should be made to open and close several times in succession to verify proper operation and remove any accumulation of dust or foreign material on moving parts and contacts.

The circuit breakers mainly consist of the interrupter assembly (contacts, arc interrupters and arc chutes), operating mechanism, operation rod, control panel, sealing system, and breaking medium (SF<sub>6</sub>, oil, vacuum, and air). To ensure the performance of a circuit breaker, all the components should be kept in good condition; therefore time-directed preventive maintenance has been widely adopted. The maintenance practices can be divided into three categories: corrective maintenance, preventive maintenance, and predictive maintenance. Since the maintenance information is distributed among different systems, a software technique that has the flexibility of interfacing with multiple heterogeneous information systems is desired.

#### Mobile Agent Software:

There are different definitions of what is a software agent. An agent is a proactive software component, which can act reasonably to accomplish tasks on behalf of the user. An agent should be autonomous and have sound intelligence. Agent-based programming offers greater flexibility and adaptability than component-based programming.

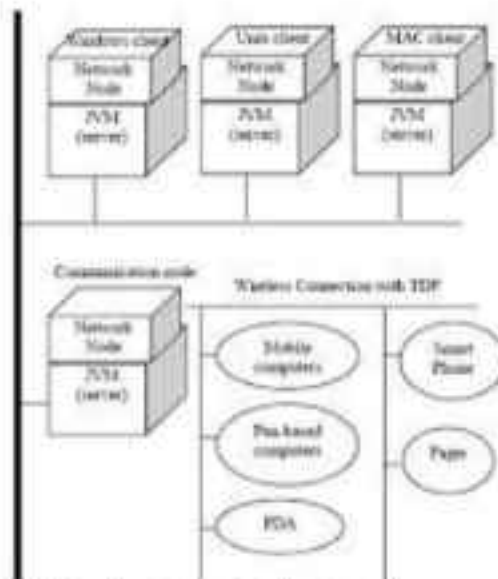


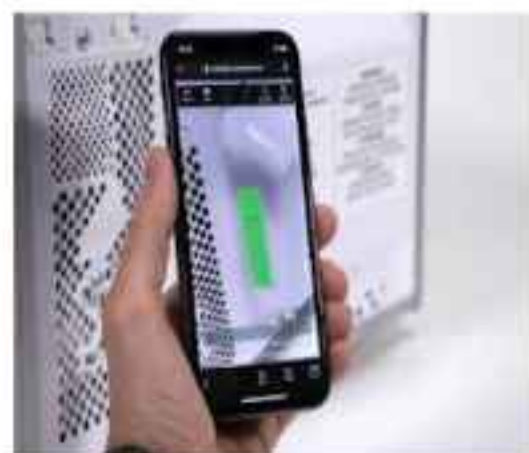
Fig. 1. A typical network setup of a mobile agent system.

Agents communicate with each other by passing messages or by synchronization. Depending on their functions, we can classify agents into several categories like Personal agents, mobile agents, collaborative agents, etc. Mobile agents are small software entities that can travel around the network, performing their functions on behalf of users. As the next generation middle-ware infrastructure for developing distributed applications, it meets all the requirements mentioned above. The mobile agent server can run on any platform where the Java runtime environment is available, and the devices without Java Virtual Machine (JVM) are supported through a communication node.

#### Application Scenarios:

To reflect the distributed characteristic of the data sources, three computers are used to represent the enterprise maintenance system, the substation concentrator and the maintenance crew respectively as shown in Figure Information Storage and Retrieval. The mobile agent can help storing and retrieving all the information needed to

perform maintenance or repair work. Mobile agent software supports accessing the data saved into heterogeneous systems. The heterogeneity may be reflected platform wise (differences in protocol, differences in format), concept wise (differences in schema and vocabulary, relative incompleteness), or both. Mobile agent software provides a framework to work in heterogeneous environments. At first, the Java platform is highly portable, which makes the mobile agent server run on a plethora of platforms. Second, the mobile agent server will save the status of mobile agents, therefore providing reliable transmits on slow or part-time connected networks.



#### **Circuit Breaker Monitoring:**

The distributed event mechanism is helpful in monitoring the status and events of circuit breakers. The user can select the event of interest to monitor. Once the monitoring starts, the selected events will

be registered with the mobile agent server running on the corresponding substation concentrator. The concentrator can get the real time information about the circuit breakers by communicating with sensors, and it can notify the user when the selected type of event happens. Security Consideration Two apparent security problems arise when applying mobile agents. First, the mobile agents need to be authenticated and authorized at the servers. Second, to ensure the integrity of the data, it must be transmitted in secure communication channels. Every mobile agent must be authenticated at first to identify whom it represents. Secure Agent supports user authentication by using the username/password pairs. Once identified, mobile agents can be checked against the security policy to see whether they are authorized to do certain things at a server. For example, agents can improve the usability of some software by providing a friendly user interface with ability of speech recognition and synthesis. So Mobile agent software may be suitable for applying in circuit breaker maintenance practice due to its support for heterogeneous systems, security, distributed events, low-bandwidth usage, etc. Using the mobile agent software, the development work can be greatly simplified.

\*\*\*\*\*

**EDITORIAL BOARD**  
**FACULTY COORDINATORS**

Dr. R. Sankerganesh, ASP/EEE,  
Mr. P. Manikandan, AP/EEE,

**STUDENT COORDINATORS**

73152314047- SARIKA P, III EEE  
73152314049- SHREENITHI G, III EEE  
73152314048- SHIVARANJAN K, III EEE

