BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Electrical Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, III Semester,

End Sem. Examination

Course Code: ELE1301 **Time: 2 Hour**

Course Name: Automation and Control **Max. Marks: 50**

Instruction: Answer all questions from each and every section. Section A, each question carries one mark, section B, each question carries four marks and in section C, each question carries six marks. Scientific calculator is allowed.

Section – A

10X01 = 10 Marks

1. What is the meaning of the rung being TRUE in the ladder logic program of PLC.

a) 0 b) 1

c) Either (a) and (b) d) None of these

2. What is the mean of NO switch?

a) Normally Opened Switch b) Normally Closed Switch

c) Both (a) and (b) d) None of these

3. HMI stands for _____.

a) High Machine Interface b) Human Machine Intelligence

c) Human Machine Interface d) None of these

4. Which syntax is right for the output in the ladder logic programming of PLC?

a) O:0/5 b) I:1/8

c) T3:6 d) B3:4/6

5. Which is the example of input devices?

a) Lamp b) Switch

c) Fan d) None of these

6. Which is the basic part of ladder logic diagram?

a) Rung b) Rail

c) Tag d) All of these

7. The scan time ladder logic program depends on _____.

a) The Speed of processor module b) The length of ladder program

c) The type of instructions executed d) All of these

8. The ADD function is used to _____ the two values in the ladder logic program.

a) Subtract b) Add

c) Multiply d) Divide

9. Which function is used for AND logic gate?

a) A+B b) A.B

c) A/B d) A-B

10. The connection of the power supply VDC (-) to the input group's COM terminal is called _____.

Set A

a) Sinking Input
b) Sourcing Input
c) Either (a) or (b)
d) None of these

Section – B

04X04 = 16 Marks

1. What is the automation? Explain the need and role of automation in the industries.
2. Differentiate between software and hardware with the examples.
3. Explain the working of PLC with its flow-chart?
4. Describe the PLC ladder logic diagram for automation.

Section – C

04X06 = 24 Marks

1. Describe the six advantages of PLC in the industries.
2. Explain any three modes of operations of PLC.
3. Explain the three types of PLC programming for automation.
4. Describe the following logic gates:

(i) AND Gate

(ii) OR Gate

(iii) NOT Gate

Answers Key

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Section – A

10X01 = 10 Marks

Ans 1. (a) 0
Ans 2. (b) Normally Closed Switch
Ans 3. (c) Programmable Logic Controller
Ans 4. (b) I:1/8
Ans 5. (c) Fan
Ans 6. (c) Block
Ans 7. (d) All of these
Ans 8. (a) Subtract
Ans 9. (a) A+B
Ans 10. (b) Sourcing Input

Section – B

04X04 = 16 Marks

Ans 1.

Automation:

- Automation is the technology by which a process or procedure is performed with minimal human assistance. Automation or automatic control is the use of various control systems for operating equipment such as machinery, processes in factories, boilers and heat treating ovens, switching on telephone networks, aircraft and other applications and vehicles with minimal or reduced human intervention.
- In the simplest type of an automatic control loop, a controller compares a measured value of a process with a desired set value, and process the resulting error signal to change some input to the process, in such a way that the process stays at its set point without disturbances.

Evaluation of automation:

- The technology of automation has evolved from the related field of mechanization, which had its beginnings in the Industrial Revolution. Mechanization refers to the replacement of human (or animal) power with mechanical power of some form.
- The term automation was coined in the automobile industry about 1946 to describe the increased use of automatic devices and controls in mechanized production lines. The origin of the word is attributed to D.S. Harder, an engineering manager at the Ford Motor Company at that time.
- The resulting system is capable of operating without human intervention. The development of this technology has become increasingly dependent on the use of computers and computer-related technologies.

1. Manual Controlling: In manual control system, the process operator observes the process condition and controls the system by doing manual adjustments. Heron of Alexandria, a Greek mathematician, invented the first automatic door, which could open the gates to the city using a series of ropes and pulleys.

2. Pneumatic Controlling: A pneumatic system is a collection of interconnected components using compressed air to do work for automated equipment. in this case the use of a gaseous media under pressure to generate, transmit and control power; typically using compressed gas such as air at a pressure of 60 to 120 pounds per square inch (PSI). Hydraulics is another form of fluid power, which uses a liquid media such as oil but at a much higher pressure with a typical range of 800 to 5000 PSI. EX. Hydraulic gates

3. Hard wire controller: Hard-wired means the electrical cable is physically connected or wired into the household wiring. Ex. Hard wired counter, timer etc.

4. Electric logic gate controller: A logic gate is an idealized or physical device implementing a Boolean function that, performs a logical operation on one or more binary inputs and produces a single binary output.

5. PLC: A PLC is a Programmable Logic Controller. In other words, it is an industrial computer used as a standalone unit and can be used in a network of PLCs to automatically control a process or perform a specific function.

Ans 2.

Input and Output:

PLC I/O is the part of the PLC that connects the brain of the PLC, the CPU, to the outside world, the machines. In a PLC system there will usually be dedicated modules for inputs and dedicated modules for outputs. An input module detects the status of input signals such as push-buttons, switches, temperature sensors, etc. An output module controls devices such as relays, motor starters, lights, etc.

Ans 3.

Scan Cycle of PLC Program:

- When a PLC execute a program, it must know in real time when external devices controlling a process are changing. During each operating cycle, the processor reads all the inputs, takes these values, and energizes or de-energizes the output according to the user program. This process is known as program scan cycle. Fig. illustrates a single PLC operating cycle consisting of the input scan, program scan, output scan and housekeeping duties. It constantly repeats this cycle as long as the PLC is in the RUN mode.
- The time it takes to complete a scan cycle is called the scan cycle time and indicates how fast the controller can react to change in inputs. The time required to make a single scan can vary from about 1 millisecond to 20 milliseconds. The actual scan time is calculated and stored in the PLC's memory. The PLC computes the scan time each time the END instruction is executed.
- "The scan is normally a continuous and sequential process of reading the status of inputs, evaluating the control logic, and updating the output.

Scan process for a single Rung programme:

Answers Key

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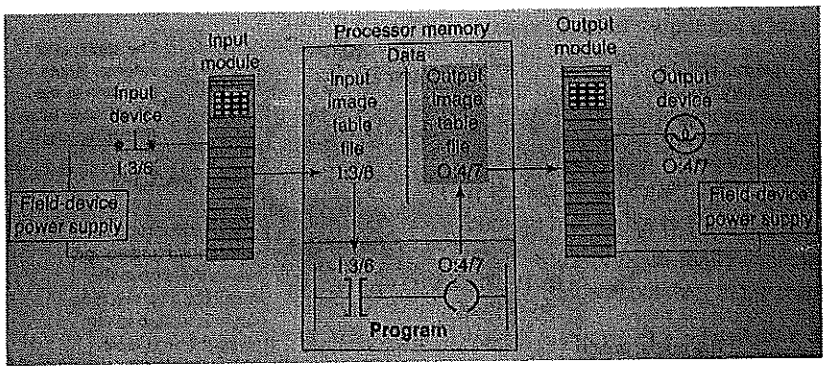
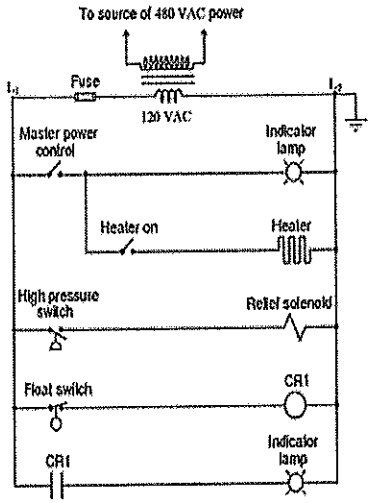


Ans 4.

Relay Ladder logic diagram:

- Ladder diagrams, or Relay Ladder Logic (RLL), are the primary programming language for programmable logic controllers (PLCs). Ladder logic programming is a graphical representation of the program designed to look like relay logic. This convention goes back to the early days of PLCs when electricians and technicians were trained in relay logic and expected to troubleshoot these new devices as well.
- The drawings show both the similarities and differences in the two types of programs. The relay logic drawing shows switches electrically connected to coils-solenoids, pilot lights, etc. The ladder diagram uses contacts to represent the switches, or any input, and the coil symbol to represent an output. A line showing an input or several inputs and an output is known as a rung.
- The relay diagram used electrical continuity to show a rung as electrically closed. Ladder logic programming shows the results of a status check of the inputs and outputs where the conditions are true or not true. The original intent of RLL was to provide a way for the controller to solve logic sequences involving discrete signals.



Section – C

04X06 = 24 Marks

Ans 1.

Architecture of PLC:

Answers Key

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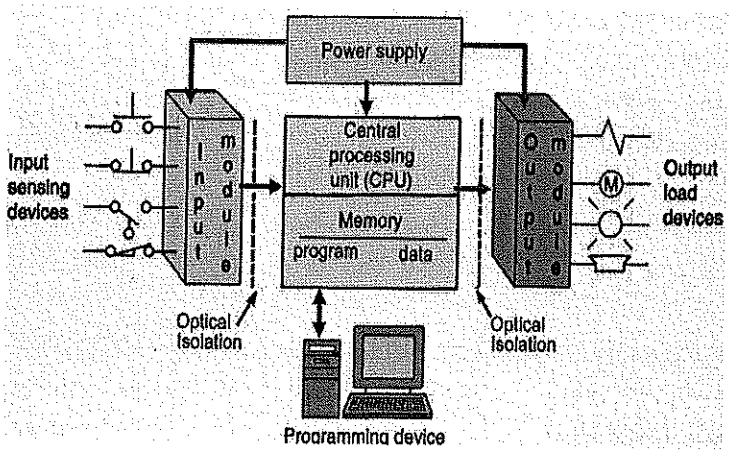


- Input module accepts signals from sensors or buttons and convert signal into a logic signal. example: switches, push buttons, sensors etc.
- Output module convert control instructions or logic into mechanical output signal that can be used by output devices. example: lamps, alarm etc.
- Power supply:- It Provides the particular voltage needed to run the primary PLC components.
- Relay:- Relays are switches that open and close circuits electromechanically. Relays control one electrical circuit by opening and closing contacts in another circuit.
- The processor module consists of the central processing unit (CPU) and memory. In addition to a microprocessor, the CPU also contains at least an interface to a programming device and may contain interfaces to remote I/O and other communication networks.
- Programing device is used to develop, Download and upload the ladder logic program into the processor of PLC.

Ans 2.

Steps for troubleshooting an equipment:

1. Preparation

- Before you begin to troubleshoot any piece of equipment, you must be familiar with your organization's safety rules and procedures for working on electrical equipment. These rules and procedures govern the methods you can use to troubleshoot electrical equipment (including your lockout/ tagout procedures, testing procedures etc.) and must be followed while troubleshooting.
- You need to gather information regarding the equipment and the problem. Be sure you understand how the equipment is designed to operate. It is much easier to analyse faulty operation when you know how it should operate. Operation or equipment manuals and drawings are great sources of information.

2. Observation

- Most faults provide obvious clues as to their cause. Through careful observation and a little bit of reasoning, most faults can be identified as to the actual component with very little testing.

- Look for signs of overheating, especially on wiring, relay coils, and printed circuit boards. Don't forget to use your other senses when inspecting equipment. Listening to the sound of the equipment operating may give you a clue to where the problem is located.

3. Define Problem Area

- To help you define the problem area you should have a schematic diagram of the circuit in addition to your noted observations.
- Starting with the whole circuit as the problem area, take each noted observation and ask yourself "what does this tell me about the circuit operation?" If an observation indicates that a section of the circuit appears to be operating properly, you can then eliminate it from the problem area. As you eliminate each part of the circuit from the problem area, make sure to identify them on your schematic. This will help you keep track of all your information.

4. Identify Possible Causes

- Once the problem area(s) have been defined, it is necessary to identify all the possible causes of the malfunction. This typically involves every component in the problem area(s).

5. Determine Most Probable Cause

- Once the list of possible causes has been made, it is then necessary to prioritize each item as to the probability of it being the cause of the malfunction.

6. Test and Repair

- Testing electrical equipment can be hazardous. The electrical energy contained in many circuits can be enough to injure or kill. Make sure you follow all your companies safety precautions, rules and procedures while troubleshooting.
- There are many types of test instruments used for troubleshooting. Some are specialized instruments designed to measure various behaviours of specific equipment, while others like the multimeter are more general in nature and can be used on most electrical equipment. A typical multimeter can measure AC and DC Voltages, Resistance, and Current.

Ans 3.

Basics of Ladder Logic Diagram:

There are seven basic parts of a ladder diagram that are essential to know how to draw ladder logic diagrams.

(1) Rails – There are two rails in a ladder diagram which are drawn as vertical lines running down the far most ends of the page. If they were in a relay logic circuit they would represent the active and zero volt connections of the power supply where the power flow goes from the left hand side to the right hand side.

(2) Rungs – The rungs are drawn as horizontal lines and connect the rails to the logic expressions. If they were in a relay logic circuit they would represent the wires that connect the power supply to the switching and relay components.

(3) Inputs – The inputs are external control actions such as a push button being pressed or a limit switch being triggered. The inputs are actually hardwired to the PLC terminals and represented in the ladder diagram by a normally open (NO) or normally closed (NC) contact symbol.

(4) Outputs – The outputs are external devices that being are turned on and off such as an electric motor or a solenoid valve. The outputs are also hardwired to the PLC terminals and are represented in the ladder diagram by a relay coil symbol.

(5) Logic Expressions – The logic expressions are used in combination with the inputs and outputs to formulate the desired control operations.

(6) Address Notation & Tag Names – The address notation describes the input, output and logic expression memory addressing structure of the PLC. The tag names are the descriptions allocated to the addresses.

(7) Comments –The comments are an extremely important part of a ladder diagram. Comments are displayed at the start of each rung and are used to describe the logical expressions and control operations that the rung, or groups of rungs, are executing. Understanding ladder diagrams is made a lot easier by using comments.

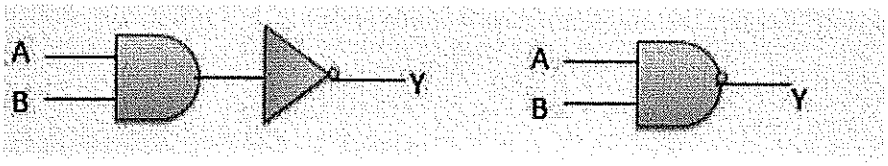
Ans 4.

PLC Program of logic gates:

(i) NAND Gate: NOT-AND operation is known as NAND operation. It has n input (n >= 2) and one output.

Y = A NOT AND B NOT AND C ..... N
Y = A NAND B NAND C ..... N

Logic diagram:



Truth Table:

Inputs		Output
A	B	$\overline{AB}$
0	0	1
0	1	1
1	0	1
1	1	0

Answers Key

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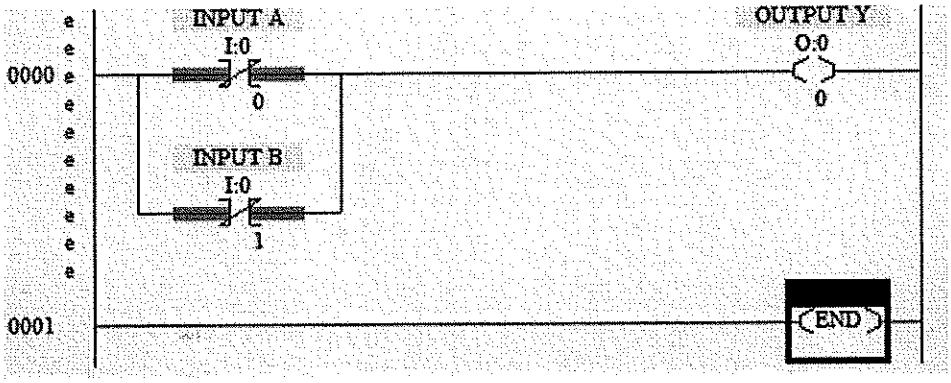
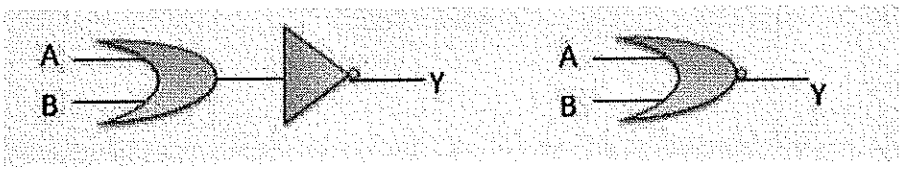
PLC Program:



(ii) NOR Gate: A NOT-OR operation is known as NOR operation. It has n input (n >= 2) and one output.

Y = A NOT OR B NOT OR C ..... N
Y = A NOR B NOR C ..... N

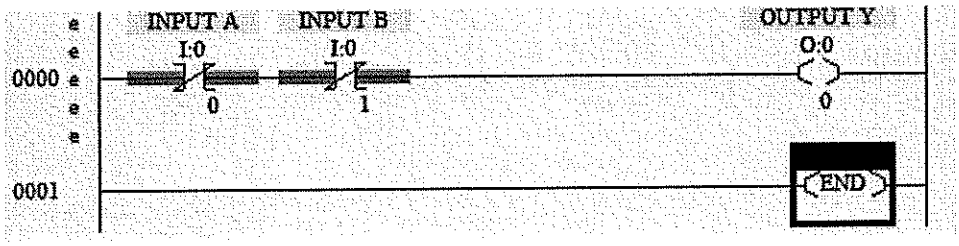
Logic diagram:



Truth Table:

Inputs		Output
A	B	$\overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

PLC Program:



(iii) NOT Gate: NOT gate is also known as Inverter. It has one input A and one output Y.

Y = NOT A
Y = $\overline{A}$

Logic diagram:

Answers Key

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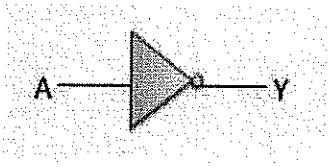
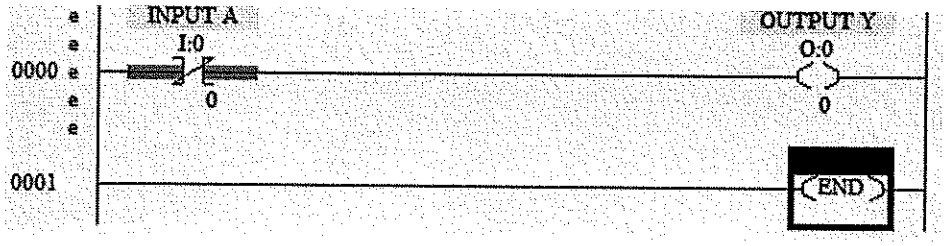


Truth Table:

Inputs	Output
A	B
0	1
1	0

PLC Program:



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Course Code: ELE1301 **Time: 2 Hour**

Course Name: Automation and Control **Max. Marks: 50**

Instruction: Answer all questions from each and every section. Section A, each question carries one mark, section B, each question carries four marks and in section C, each question carries six marks. Scientific calculator is allowed.

Section – A

10X01 = 10 Marks

1. What is the meaning of the rung being FALSE in the ladder logic program of PLC.

a) 0 b) 1

c) Either (a) and (b) d) None of these

2. What is the mean of NC switch?

a) Normally Opened Switch b) Normally Closed Switch

c) Both (a) and (b) d) None of these

3. PLC stands for _____.

a) Program Low Circuit b) Power Logic Controller

c) Programmable Logic Controller d) None of these

4. Which syntax is right for the input in the ladder logic programming of PLC?

a) O:0/5 b) I:1/8

c) T3:6 d) B3:4/6

5. Which is the example of output devices?

a) Sensor b) Switch

c) Fan d) None of these

6. Which is not the basic part of ladder logic diagram?

a) Rung b) Rail

c) Block d) All of these

7. The scan time ladder logic program depends on _____.

a) The Speed of processor module b) The length of ladder program

c) The type of instructions executed d) All of these

8. The SUBTRACT function is used to _____ the two values in the ladder logic program.

a) Subtract b) Add

c) Multiply d) Divide

9. Which function is used for OR logic gate?

a) A+B b) A.B

c) A/B d) A-B

10. The connection of the power supply VDC (+) to the input group's COM terminal is called _____.

set B

a) Sinking Input
b) Sourcing Input
c) Either (a) or (b)
d) None of these

Section – B

04X04 = 16 Marks

1. Describe the automation and the evaluation of the automation.
2. Differentiate between input and output devices with the examples.
3. Explain the scan cycle of PLC program with the single rung program.
4. Describe the relay ladder logic diagram for automation.

Section – C

04X06 = 24 Marks

1. Describe the architecture of PLC with its components.
2. Explain six steps of troubleshooting approach for an equipment.
3. Explain the six basic parts of a ladder logic diagram of PLC programming.
4. Describe the following logic gates:

(i) NAND Gate

(ii) NOR Gate

(iii) NOT Gate

Answers Key

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Section – A

10X01 = 10 Marks

Ans 1. (b) 1
Ans 2. (a) Normally Opened Switch
Ans 3. (c) Human Machine Interface
Ans 4. (a) O:0/5
Ans 5. (b) Switch
Ans 6. (d) All of these
Ans 7. (d) All of these
Ans 8. (b) Add
Ans 9. (b) A.B
Ans 10. (a) Sinking Input

Section – B

04X04 = 16 Marks

Ans 1.

Automation:

Automation is the technology by which a process or procedure is performed with minimal human assistance. Automation or automatic control is the use of various control systems for operating equipment such as machinery, processes in factories, boilers and heat treating ovens, switching on telephone networks, aircraft and other applications and vehicles with minimal or reduced human intervention.

In the simplest type of an automatic control loop, a controller compares a measured value of a process with a desired set value, and process the resulting error signal to change some input to the process, in such a way that the process stays at its set point without disturbances.

Need and Role of Automation:

1. **Reduce Worker Fatigue and Effort or Labour Intensive Operation:** Typically, humans dislike banal, repetitive tasks. However, computer systems perform them without complaint.
2. **Prevent Products or Materials from Being Damaged or Destroyed:** Humans make mistakes when they fatigue. This embodies the sentiment of the "human condition." Mistakes using tools mean damaging raw materials, components, assemblies, and end products.
3. **Prevent Non-Conforming Product from Shipping:** Computers controlling robots do not forget steps. Neglecting to put in a screw requires a human touch.
4. **Increase Efficiency:** Improving processes for efficiency makes a company more competitive, but do people always do the same thing, in the same way, every time they do it? No, human variation exists. Automated systems allow for improvements that benefit from consistent execution.
5. **Collect Better Data:** Remove the accidental data entry or missed data point from logging. Different sensors regulate it.

6. **Improve Metrics:** Sending reliable data directly to a database provides an ongoing resource. Correlation of associated process data with pass/fail records provides insight rather than guessing "what is causing this?".
7. **Devise the Right Process Improvements:** Automated systems now collect reliable data. The database provides a searchable forum. It makes "continuous improvement," make changes with better information.
8. **Save Money:** Cost savings through making processes more regular and collecting data for making confident decisions.

Ans 2.

Hardware:

- The PLC comes with its program language built into its memory and has no the permanently attached keyboard CD drive or monitor. While computers are permanently attached to a keyboard and other hardware.
- Computers are complex computing machines capable of executing several programs or tasks simultaneously and in any order. Most PLCs, on the other hand, execute a single program in an orderly and sequential fashion from first to last instruction.
- PLCs come equipped with terminals for input and output field devices as well as communication ports. PCs have only limited ports and terminals.
- PLC control systems have been designed to be easily installed and maintained. Troubleshooting is simplified by the use of fault indicators and messages displayed on the programmer screen.
- Input/output modules for connecting the field devices are easily connected and replaced in PLC.

Software:

- PLC software that allows the user to only program and document gives the user the tools to write a PLC program. While a PC has much more options in adding programs.
- The PLC support Ladder logic programming.
- PLC software that allows the user to monitor and control the process is also called a human machine interface (HMI). It enables the user to view a process—or a graphical representation of a process—on a monitor, determine how the system is running, trend values, and receive alarm condition.
- Programmable automation controllers (PAC) combine PLC ruggedness with PC functionality. Using PACs, you can build advanced systems incorporating software capabilities such as advanced control, communication, data logging, and signal processing with rugged hardware performing logic, motion, process control, and vision.

Ans 3.

Answers Key

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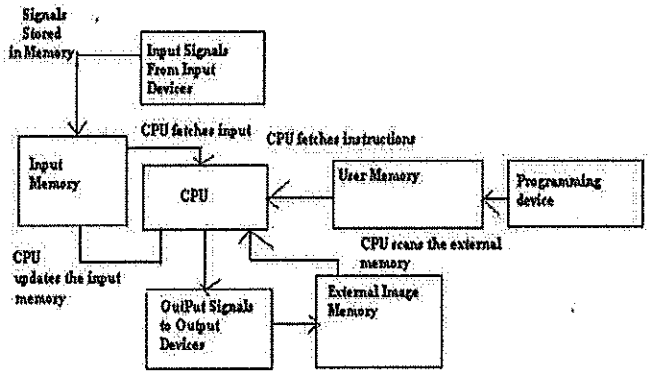
Working of PLC:

- The input sources convert the real time analog electric signals to suitable digital electric signals and these signals are applied to the PLC through the connector rails.
- These input signals are stored in the PLC input memory in locations known as bits. This is done by the CPU
- The control logic or the program instructions are written onto the programming device through symbols or through mnemonics and stored in the user memory.
- The CPU fetches these instructions from the user memory and executes the input signals by manipulating, computing, processing them to control the output devices.
- The execution results are then stored in the external image memory which controls the output drives.
- The CPU also keeps a check on the output signals and keeps updating the contents of the input image memory according to the changes in the output memory.
- The CPU also performs internal programming functioning like setting and resetting of the timer, checking the user memory.



Ans 4.

Ladder Logic Program:

- Ladder logic is the most common programming language used in Programmable Logic Controllers (PLC). It's used extensively in a multitude of industrial applications for automating machinery and processes.
- Ladder diagrams are used to represent logical expressions in graphical form. So writing a ladder logic program using ladder diagrams is kind of the equivalent of drawing a relay control circuit.
- Maintenance staff in industrial sites already understand how to read relay control circuits using ladder diagrams. Therefore, using ladder logic as a method of PLC programming for automating machinery and processes means ease troubleshooting PLC ladder logic problems.

Section – C

04X06 = 24 Marks

Ans 1.

Advantages of PLC:

Answers Key

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1. **Increased Reliability:** Once a program has been written and tested, it can be easily downloaded to PLC. Since all the logic is contained in the PLC's memory there is no change of making a logic wiring error.
2. **More flexibility**: It is easier to create and change a program in a PLC than to wire and rewire the circuit. With a PLC the relationship between the input and output are determined by the user program instead of manner in which they are interconnected.
3. **Lower cost:** PLC were originally designed to replace relay control logic, and the cost saving have so significant that relay control is becoming obsolete except for power applications.
4. **Communication capability:** A PLC can communicate with other controllers such as Human machine Interface, Supervision control, Data gathering, Monitoring devices and process parameters.
5. **Faster Response time:** PLCs are designed for high-speed and real-time applications. The PLC operates in real time, which means that an event taking place in the field will result in the execution of an operation or output. Machines that process thousands of items per second and objects that spend only a fraction of second in front of a sensor require the PLC's quick-response capability.
6. **Easier to troubleshoot:** PLC's have resident Diagnostics and override functions that allow user to easily trace and correct software and hardware problems. To find and fix problems user can display the control program on a monitor and watch it in real time as it executes.

Ans 2.

Modes of operations of PLC:

A processor has basically two modes of operations: the program mode and some variations of the run mode. The number of different operating modes and the methods of accessing them varies with the manufacturer. Fig. shows a typical three position key switch used to select different processor modes of operation. Some common operating modes are explained as follows:

1. Program Mode: The program mode is used to enter a new program, edit or update an existing program, upload files, download files, document (print out) programs, or change any software configuration file in the program. When the PLC is switched into the program mode, all output is forced off regardless of their rung logic status, and the ladder I/O scan sequence is halted.

2. Run Mode: The Run Mode is used to execute the user program. Input devices are monitored and output devices are energized accordingly. After all instructions have been entered in a new program or all changes made to existing program, the processor is put in the run mode.

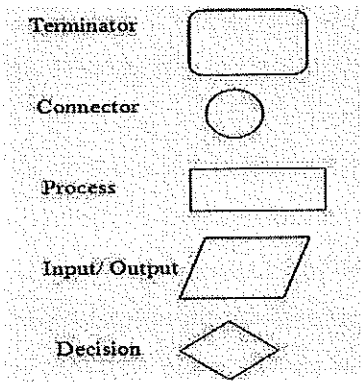
3. Test Mode: The test mode is used to operate or monitor the user program without energizing any outputs. The processor still reads inputs, executes the ladder program, and update the output status table files, but without energizing the output circuit. This feature is often used after developing or editing a program to test the program execution before allowing the PLC to operate real-world outputs.

4. Remote Mode: In the Run position, all logic is solved and I/O is enabled. In the program position, all logic solving is stopped and the I/O is disabled. The remote position allows the PLC to be remotely changed between program and run mode by personal computer connected to the PLC processor. The remote mode may be beneficial when the controller is in a location that is not easily accessible.

Ans 3.

Types of PLC programming:

1. Flowchart: A flowchart is the symbolic representation of the instructions. It is the most basic and simplest form of control logic which involves only logic decisions. Different symbols are as given below:



2. Boolean algebra: Boolean algebra usually involves logic operations like AND, OR, NOT, NAND and NOR. The different symbols are:

(+) Or operator

(.) AND operator

(!)NOT operator.

3. Statement logic: The instructions in simple statement forms can be written as:

"IF Input1 AND Input2 is TRUE Then SET Output1 ELSE SET Output2"

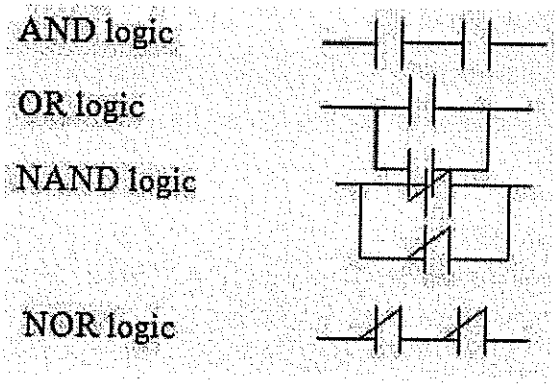
4. Mnemonics Logic: Mnemonics are instructions written in symbolic form. They are also known as Opcode and are used in handheld programming devices. Different Symbols are as given below:

Ldi – Load Inverse	OR-		Or	logic
Ld- Load	ANI	–	NAND	logic
AND- And logic	ORI-		NOR	logic
Out – Output				

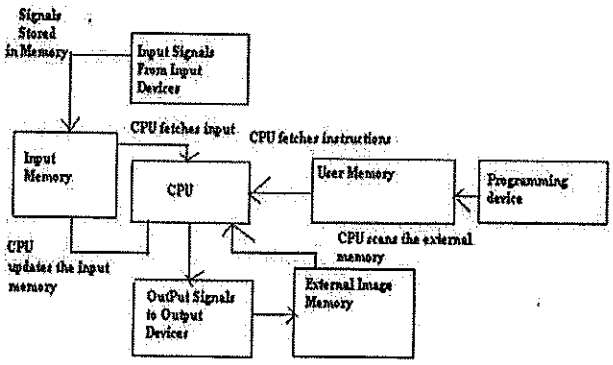
Answers Key

Course Code: ELE1301, Course Name: Automation and Control
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, III Semester, End Sem. Examination

5. Ladder logic programming: It is the most important part of PLC programming. Before explaining about ladder logic programming, let us know about few symbols and terminologies Rung: One step in the ladder is called a rung. In simpler words, the basic statement or one control logic is called a Rung. Examples of ladder logic programming



- The input sources convert the real time analog electric signals to suitable digital electric signals and these signals are applied to the PLC through the connector rails.
- These input signals are stored in the PLC external image memory in locations known as bits. This is done by the CPU
- The control logic or the program instructions are written onto the programming device through symbols or through mnemonics and stored in the user memory.
- The CPU fetches these instructions from the user memory and executes the input signals by manipulating, computing, processing them to control the output devices.
- The execution results are then stored in the external image memory which controls the output drives.
- The CPU also keeps a check on the output signals and keeps updating the contents of the input image memory according to the changes in the output memory.
- The CPU also performs internal programming functioning like setting and resetting of the timer, checking the user memory.



Ans 4.

Answers Key

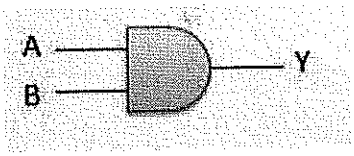
Course Code: ELE1301, Course Name: Automation and Control
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, III Semester, End Sem. Examination

PLC Program logic gates:

(i) AND Gate: A circuit which performs an AND operation is shown in figure. It has n input (n >= 2) and one output.

Y	=	A AND B AND C ..... N
Y	=	A.B.C ..... N
Y	=	ABC ..... N

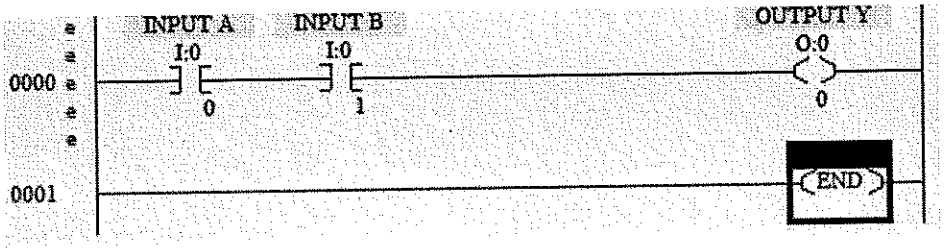
Logic diagram:



Truth Table:

Inputs		Output
A	B	AB
0	0	0
0	1	0
1	0	0
1	1	1

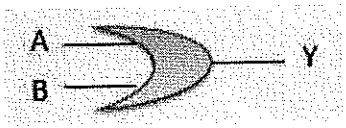
PLC program:



(ii) OR Gate: A circuit which performs an OR operation is shown in figure. It has n input (n>=2) and one output.

Y	=	A OR B OR C ..... N
Y	=	A + B + C ..... N

Logic diagram:



Truth Table:

Answers Key

Course Code: ELE1301, Course Name: Automation and Control
School of Electrical Skills, Session: 2021-22 (Summer Semester)
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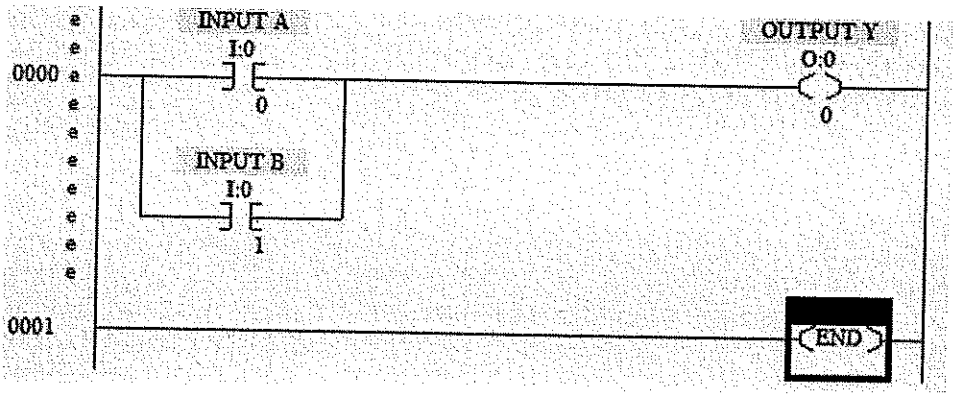
Inputs		Output
A	B	A + B
0	0	0
0	1	1
1	0	1
1	1	1

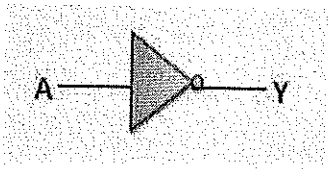
PLC program:



(iii) NOT Gate: NOT gate is also known as Inverter. It has one input A and one output Y.

$Y = NOT\ A$
$Y = \overline{A}$

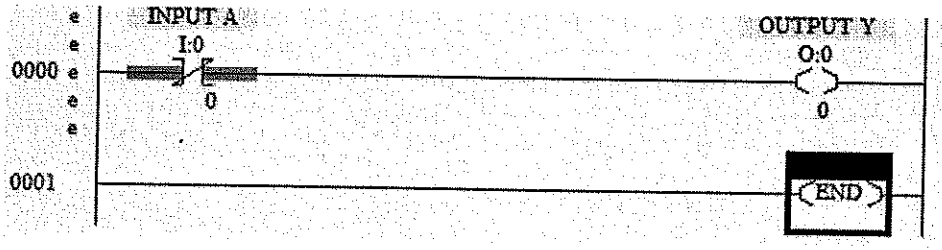
Logic diagram:



Truth Table:

Inputs	Output
A	B
0	1
1	0

PLC program:



BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.....

School of Electrical Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, III Semester

End-Sem. Examination

Course Code: Electrical measuring instruments **Time: 2 Hours**

Course Name: ELE 1304 **Max. Marks: 50**

Instruction: Answer all questions from each and every section. Section A, each question carries one mark, section B, each question carries four marks and in section C, each question carries six marks. Scientific calculators are allowed.

Section – A

10X01 = 10 Marks

1. SI Units of charge is_____
   (A) Henry (B) Ohm (C) Coulomb (D) Watt
2. What does a tachometer measure?
   (A) Voltage (B) Resistance (C) RPM (D) Radiation
3. Calibration is used for____
   (A) Voltage test (B) Current test (C) RPM (D) None of these
4. Symbol of capacitance is_____
   (A) F (B) C (C) J (D) H
5. Which sensor is used for fire Protection?
   (A) Smoke (B) LDR (C) Motion (D) Pressure
6. An analog ammeter is used to measure_____
   (A) Ampere (B) Voltage (C) Resistance (D) Connection
7. Quantity of Kelvin is_____
   (A) Second (B) Candela (C) Temperature (D) Mole
8. The electrical instrument is used for measure_____
   (A) Voltage (B) Current (C) Resistance (D) All of these
9. Which torque is used to reduce the oscillation in meter?
   (A) Restoring torque (B) Damping torque (C) Controlling torque (D) Operating
10. Which one is a secondary instrument?
    (A) Voltmeter (B) Watt meter (C) Ammeter (D) All of these

Set A

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Section – B

04X04 = 16 Marks

1. What is transducers?
2. Explain about electronic energy meter.
3. What is indicating instruments?
4. What is measurement and measuring instruments?

Section – C

04X06 = 24 Marks

1. Explain about systematic error.
2. What is source of error? Explain.
3. Write the standard of measurement.
4. Write the use of voltmeter, ammeter and megger.

Answers Key

Course Code: ELE1304 Name: Electrical measuring instruments Course
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, III Semester, End-Sem. Examination

Section-A

1. C
2. C
3. D
4. A
5. A
6. A
7. C
8. D
9. B
10. D

Section-B

1. (Ans.)

A transducer is a device that converts energy from one form to another. Usually a transducer converts a signal in one form of energy to a signal in another. A transducer is an electronic device that converts energy from one form to another. Common examples include microphones, loudspeakers, thermometers, position and pressure sensors, and antenna. ... Some antennas approach 100-percent efficiency.

(A) Loudspeakers

(B) Microphones

(C) Thermometers

(D) LEDs.

2. (Ans.)

An electric meter, or energy meter, is a device that measures the amount of electric energy consumed by a building, tenant space, or electrically powered equipment. Electric utilities use electric meters installed at customers' premises to measure electric energy delivered to their customers for billing purposes.

3. (Ans.)

Indicating instruments: - (Display)

It indicates the magnitude or Value or reading of an electrical quantity at the time when it is being measured. The indications are given by a pointer moving over a graduated dial. All Type Analog Voltmeter, ammeter, etc.

Answers Key

Course Code: ELE1304 Name: Electrical measuring instruments Course
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, III Semester, End-Sem. Examination

4. (Ans.)

Measurement is finding a number that shows the size or amount of something.

OR

Process by which one can convert physical parameter into meaning full number.

What is measuring Instrument: -

An instrument is a device in which we can determine the magnitude or value of the quantity to be measured. The measuring quantity can be voltage, current, power and energy etc.

Section-C

1. (Ans.)

These errors can be divided into three different categories.

1. Instrumental errors
2. Environmental errors
3. Observational errors

Instrumental errors = These errors can be defined as the shortcomings of the instruments owing to their mechanical structure and they are always there.

For example, incorrect friction compensation reduces tension in the spring, over-stretching of the spring due to overloading the instrument, incorrect zero adjustment and weakening or reducing the strength of the permanent magnets with the passage of time etc.

Error in calibration also causes the instrument to read high or low along its entire scale.

Instrumental error can be avoided by taking the following steps.

1. Applying correction factors after determining the instrumental error
2. Calibrating the instrument against the reference standard that are known to be reliable otherwise it should be sent for checking to a measurement laboratory having such standards

Environmental errors = This type of error arises in the measurement due to the effect of the external conditions on the measurement. The external condition includes temperature, pressure, and humidity and can also include an external magnetic field.

Observational errors: -These errors are introduced due to the carelessness of the observer. Several people using the same equipment for various sets of measurements, do not necessarily produce the same result. One observer may read meter higher or lower than the true value.

Answers Key

Course Code: ELE1304 Name: Electrical measuring instruments Course
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, III Semester, End-Sem. Examination

2. (Ans.) There are a variety of factors that can lead to measurement errors. Errors typically arise from three sources;

1.Natural errors

2.Instrument errors

3.Human errors

*Natural Errors are caused by environmental conditions or significant changes in environmental conditions. Wind speed, air temperature, atmospheric pressure, humidity, gravity, earth curvature, and atmospheric refraction are examples of natural error sources.

*Instrument Errors are caused by imperfectly constructed, adjusted, or calibrated surveying equipment. Most of these errors can be reduced by properly leveling the instrument, balancing, reducing measurement distances, and observing direct and reverse positions.

*Human Errors are caused by physical limitations and inconsistent setup and observation habits o the surveyor. These errors will always be present to some degree in every observation. However, by following established setup and collection procedures, many potential errors can be minimized.

3. (Ans.)**1. International standard: -**Are defined by international agreements. These standards are maintained at the International Bureau of Weight and Measures in Paris. Frances, they are periodically evaluated and checked by absolute measurements in term of the fundamental units of physics. They represent certain units of measurement to the closest possible accuracy attained by the science and technology of measurement and used for comparison with primary standards.

2. **Primary standard: -**The Standard is maintained at institution in various countries around the world, such as the National Bureau of Standard on Washington D.C, SIRIM in Malaysia. The primary standards are not available for use outside the national laboratories. Their principle function is to calibrate and verify the secondary standards.

3.Secondary standard: -Used as the basic reference standards used by measurement & calibration laboratories in the industry. Each industrial laboratory is completely responsible for its own secondary standards. Each laboratory sends its secondary standards to the national standards (primary standards) laboratory for calibration. After calibration, the secondary standards are returned to the industrial uses with the certification and checked periodically.

4.Working standard: - Working standard is the principle tools of a measurement laboratory and th lowest level of standards. They are used to check and calibrate the instruments used in the laboratory or to make comparison measurement in industrial application. As example, the standard resistor, capacitors and inductor.

Answers Key

Course Code: ELE1304 Name: Electrical measuring instruments Course
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, III Semester, End-Sem. Examination

4. (Ans.)

Multimeter = A voltmeter is an instrument used for measuring electric potential difference between two points in an electric circuit. It is connected in parallel. It usually has a high resistance so that it takes negligible current from the circuit.

Ammeter = An ammeter is a measuring instrument used to measure the current in a circuit. Electric currents are measured in Amperes, hence the name. The ammeter is usually connected in series with the circuit in which the current is to be measured.

Megger = An instrument that is used to measure insulation resistance is a Megger. It is also known as meg-ohm-meter. It is used in several areas like multi-meters, transformers, electrical wiring, Etc Megger device is used since the 1920s for testing various electrical devices which can measure greater than 1000meg-ohms.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Electrical Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, III Semester

End-Sem. Examination

Course Code: Electrical measuring instruments **Time: 2 Hours**

Course Name: ELE 1304 **Max. Marks: 50**

Instruction: Answer all questions from each and every section. Section A, each question carries one mark, section B, each question carries four marks and in section C, each question carries six marks. Scientific calculators are allowed.

Section – A

10X01 = 10 Marks

1. Which instrument required for frequency measurement?
   (A) Megger (B) Ammeter (C) Oscilloscope (D) Voltmeter
2. SI unit of conductance is_____
   (A) Coulomb (B) Siemens (C) Farad (D) Watt
3. Which torque is used to reduce the oscillation in meter?
   (A) Restoring torque (B) Damping torque (C) Controlling torque (D) Operating
4. Operating torque is requiring for____
   (A) Move pointer (B) Control pointer (C) Restore pointer (D) All of these
5. LDR is a_____
   (A) Resistance (B) IGBT (C) IC (D) BJT
6. Megger is used for_____
   (A) Voltage test (B) Amp current (C) Resistance (D) RPM
7. What does an ultrasonic sensor sense?
   (A) Voltage (B) Sound (C) Smoke (D) Frequency
8. SI unit of power is____
   (A) Watt (B) Ohm (C) Volt (D) Amp
9. What does a thermometer actually measure?
   (A) Radiation (B) Temperature (C) Light (D) Distance
10. What does a motion sensor sense?
    (A) Moment (B) Cycle (C) Sound (D) Smoke

Set B

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Section – B

04X04 = 16 Marks

1. What is damping torque?
2. Write the advantage of electrical measuring instruments?
3. What is null type instruments?
4. What is the environmental error?

Section – C

04X06 = 24 Marks

1. Write the standard of measurement.
2. Explain about any 3 sensors.
3. Write the difference between transducer and sensor.
4. Write the method to minimization of errors.

Answers Key

Course Code: ELE1304, Course Name: Electrical measuring instruments
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, III Semester, End-Sem. Examination

Section-A

1. C
2. B
3. B
4. A
5. A
6. C
7. B
8. A
9. B
10. A

Section-B

1. (Ans.)

Damping Torque: -

It is provided to reduce the oscillation in the meter. on account of the control torque, it will try to occupy a position of rest when the two torques are equal and opposite. Damping torque is used to enable fast and accurate reading of an object that undergoes oscillation. Due to inertia, an object in motion tends to stay in motion, thus requiring a counteractive force to bring it to its final rate of oscillation in a short period of time.

2. (Ans.)

Advantages of Electrical Measuring Instruments:

- They are reliable all the times
- They are more power efficient
- They are more portable in the sense
- They can be moved around easily
- They can be used in a variety of power supply all over the world.

3. (Ans.)

Null Type Instrument

In this instrument, the zero or null deflection indicates the magnitude of the measured quantity. The instrument has high accuracy and sensitivity. In null deflection instrument, the one known and one unknown quantity use. When the value of the known and the unknown measuring quantities are equal, the pointer shows the zero or null deflection. The null deflection instrument is used in the potentiometer and in galvanometer for obtaining the null point.

4. (Ans.)

Environmental Error =

This type of error arises in the measurement due to the effect of the external conditions on the measurement. The external condition includes temperature, pressure, and humidity and can also include an external magnetic field.

Answers Key

Course Code: ELE1304, Course Name: Electrical measuring instruments
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, III Semester, End-Sem. Examination

Section- C

1. (Ans.)

1. International standard: -

Are defined by international agreements. These standards are maintained at the International Bureau of Weight and Measures in Paris. Frances, They are periodically evaluated and checked by absolute measurements in term of the fundamental units of physics. They represent certain units of measurement to the closest possible accuracy attained by the science and technology of measurement and used for comparison with primary standards.

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3.Secondary standard: -

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4.Working standard: -

Working standard is the principle tools of a measurement laboratory and the lowest level of standards. They are used to check and calibrate the instruments used in the laboratory or to make comparison measurement in industrial application. As example, the standard resistor, capacitors and inductor.

2. (Ans.)

Motion Sensor= A motion sensor, or motion detector, is an electronic device that uses a sensor to detect nearby people or objects. Motion sensors are an important component of any security system. When a sensor detects motion, it will send an alert to your security system, and with newer systems, right to your mobile phone.

Smoke sensor = A smoke detector is an electronic fire-protection device that automatically senses the presence of smoke, as a key indication of fire, and sounds a warning to building occupants. Commercial and industrial smoke detectors issue a signal to a fire alarm control panel as part of a building's central fire alarm system.

Ultrasonic sensor = An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e. the sound tha humans can hear).

Answers Key

Course Code: ELE1304, Course Name: Electrical measuring instruments
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, III Semester, End-Sem. Examination

3. (Ans.)

Difference between Sensor & Transducer

No.	Differential Factors	Sensor	Transducer
01.	Definition	A sensor is a device which detects one form of energy and converts the data to electrical energy.	A transducer is a device which converts one form of energy into another. So sensors are, in fact, a type of transducer.
02.	Function	A sensor is a device which detects a physical quantity and produces an electric signal based on the strength of the quantity measured.	A transducer is a device which converts one form of energy into anther form.
03.	Sensing Element	Sensing element itself	Sensing element plus any associated circuitry
04.	Feedback	A sensor merely measures a quantity and cannot, by itself, give feedback to the system.	A transducers can convert between any forms of energy, they can be used to provide feedback to the system.

4. (Ans.)

How to Reduce Errors in Measurement Keeping an eye on the procedure and following below listed points can help to reduce the error.

1=Make sure the formulas used for measurement are correct.

2=Cross check the measured value of a quantity for improved accuracy.

3=Use the instrument that has the highest precision.

4=It is suggested to pilot test measuring instruments for better accuracy.

5=Use multiple measures for the same construct.

6=Note the measurements under controlled conditions.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Electrical Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program III Semester

End-Sem. Examination

Course Code: ELE1305 **Time: 2 Hours**

Course Name: Introduction to Power System **Max. Marks: 50**

Instruction: Answer all questions from each and every section. Section A, each question carries one mark, section B, each question carries four marks and in section C, each question carries six marks. Scientific calculator is allowed.

Section – A

10X01 = 10 Marks

1. What are the factors that affect Skin Effect?
   (a) Frequency (c) Diameter of Conductor
   (b) Shape of Conductor (d) All of the above
2. Solar, Wind and Biomass is a type of :
   (a) Conventional Source of Energy
   (b) Non- Conventional Source of Energy
   (c) Non- Renewable Source of Energy
   (d) None of the above
3. When voltage level is more than 765KV than it is known as
   (a) High voltage (c) Ultra High Voltage
   (b) Extra High Voltage (d) None of above
4. "In 3 phase AC transmission only 2 wires are used". This statement is true or false
   (a) True (b) False
5. Which of the following is the important component of an Electromechanical relay?
   (a) Lead (b) Graphite (c) Electromagnet (d) LED
6. Full form of SF6 is :
   (a) Sulphur Hexafluoride (c) Sulphur Hexafaranite
   (b) Sodium Hexafluoride (d) Silicon Hexaflauride
7. Insulator material is made up of :
   (a) Porcelain b) Glass (c) Polymer (d) All of the above
8. For a 220kV line what will be the number of disc in a suspension type insulator
   (a) ~10 (b) ~15 (c) ~20 (d) None of them
9. Current Transformer is connected in..... with the power lines. Fill in the blank.
   (a) Series (c) Parallel
   (b) Can be connected either series of parallel (d) None of the above
10. To convert steam into water again which component is used in Thermal Power Plant
    (a) Boiler (b) Draft Fan (c) Condenser (d) None of them

Set-A

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Section – B

04X04 = 16 Marks

1. Define Generating Substation and Transmission Substation.
2. Explain the working of following components

   (a) Superheater (b) Economiser (c) Consenser (d) Boiler
3. What should be the properties of a good insulator? What are the advantages of glass insulators over porcelain insulators?
4. What is relay? Explain the working principle of relay.

Section – C

04X06 = 24 Marks

1. Draw the neat and clean diagram of Thermal Power Plant and Explain its working
2. Write down the short note on :

   (a) Conventional and Non Conventional Sources of energy

   (b) Pin type and Suspension type insulator

   (c) Current Transformer and Potential Transformer.
3. Write down in detail the advantages of DC transmission over AC transmission system.
4. Explain in details about the four types of feeders used in distribution system.

Answers Key

Course Code: ELE1305 , Course Name: Introduction to Power System
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. III Semester, End-Sem. Examination

SECTION A

1. (a) Due to absence of Capacitance
2. (a) Conventional Source of Energy
3. (b) Extra High Voltage
4. (a) True
5. (b) For quenching the arc
6. (b) Electromagnetic Induction
7. (b) Pin type
8. (b) ~40
9. (c) Parallel
10. (a) Boiler

Section – B

1. Draw the neat and clean diagram of Hydro Power Plant and Explain its working .

Circuit Breaker

A circuit breaker is a switching device that interrupts the abnormal or fault current. It is a mechanical device that disturbs the flow of high magnitude (fault) current and in additions performs the function of a switch. The circuit breaker is mainly designed for closing or opening of an electrical circuit, thus protects the electrical system from damage.

Working Principle of Circuit Breaker

Circuit breaker essentially consists of fixed and moving contacts. These contacts are touching each other and carrying the current under normal conditions when the circuit is closed. When the circuit breaker is closed, the current carrying contacts, called the electrodes, engaged each other under the pressure of a spring.

During the normal operating condition, the arms of the circuit breaker can be opened or closed for a switching and maintenance of the system. To open the circuit breaker, only a pressure is required to be applied to a trigger.

2. **Explain the following:**

(a) **HV/DC transmission:** High voltage direct current (HVDC) power systems use D.C. for transmission of bulk power over long distances. For long-distance power transmission, HVDC lines are less expensive, and losses are less as compared to AC transmission. It interconnects the networks that have different frequencies and characteristics.

(b) **Transmission Substation** The transmission substation carries the overhead lines which transfer the generated electrical energy from generation to the distribution substations.

The transmission lines mainly perform the two functions

- It transports the energy from generating stations to bulk receiving stations.
- It interconnects the two or more generating stations. The neighbouring substations are also interconnected through the transmission lines.
- The transmission voltage is operating at more than 66KV and is standardised at 69KV, 115KV, 138KV, 161KV, 230KV, 345KV, 500KV, and 765KV, line-to-line. The transmission line above 230KV is usually referred to as extra high voltage (EHV).

(c) Skin Effect The non-uniform distribution of electric current over the surface or skin of the conductor carrying a.c is called the skin effect. In other words, the concentration of charge is more near the surface as compared to the core of the conductor. The ohmic resistance of the conductor is increased due to the concentration of current on the surface of the conductor. Skin effect increases with the increase in frequency. At low frequency, such as 50Hz, there is a small increase in the current density near the surface of the conductor; but, at high frequencies, such as radio frequency, practically the whole of the currents flows on the surface of the conductor. If d.c current (frequency=0) is passed in a conductor, the current is uniformly distributed over the cross-section of the conductors.

(d) Relay The relay is the device that open or closes the contacts to cause the operation of the other electric control. It detects the intolerable or undesirable condition with an assigned area and gives the commands to the circuit breaker to disconnect the affected area. Thus protects the system from damage.

3. What do you understand by Power System and What are its main component? Draw a single line diagram power system using all these components

The power system is a network which consists generation, distribution and transmission system. It uses the form of energy (like coal and diesel) and converts it into electrical energy. The power system includes the devices connected to the system like the synchronous generator, motor, transformer, circuit breaker, conductor, etc.

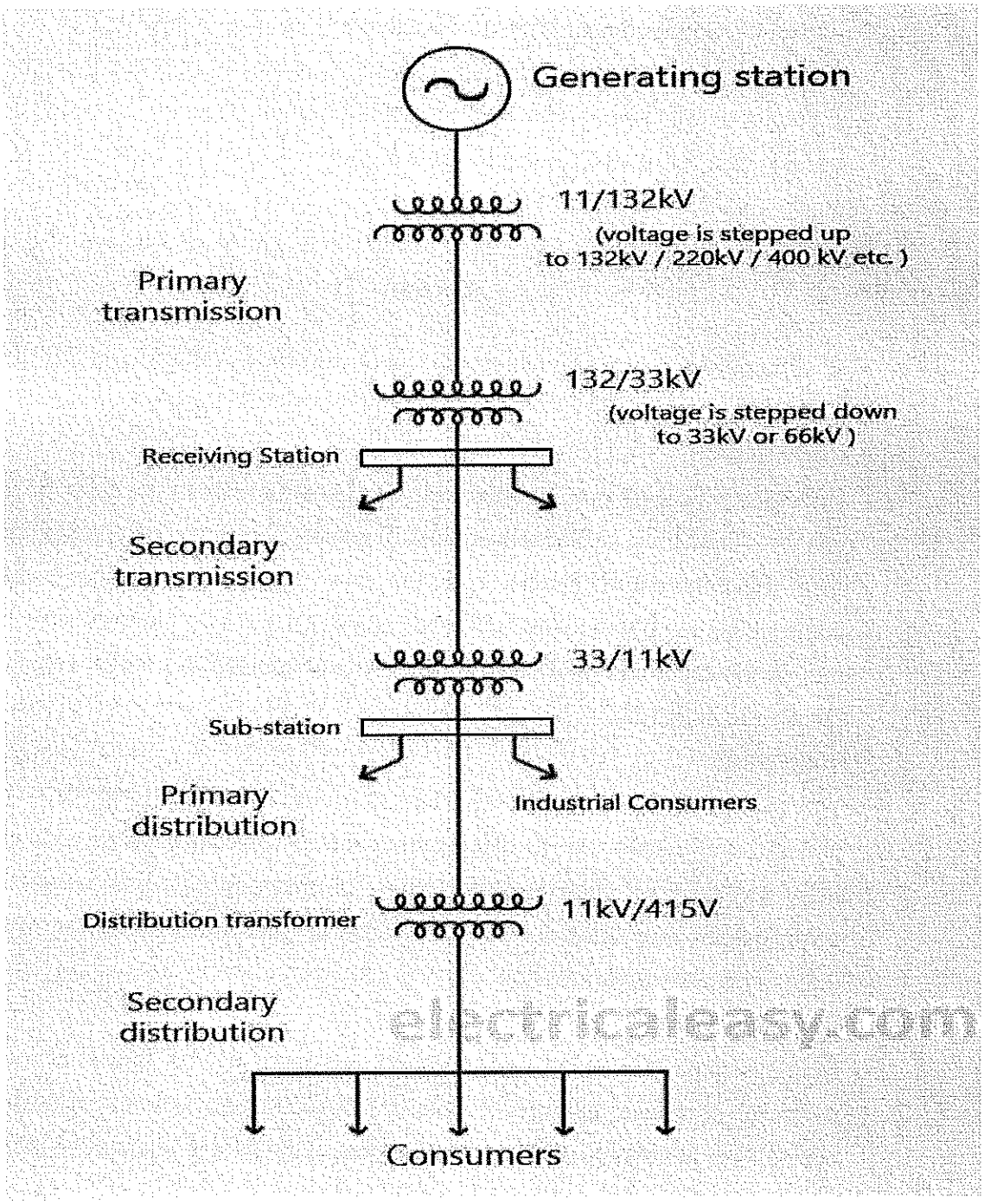
Various Components of Power System are

- Power plant
- Transformer
- Transmission line
- Substations
- Distribution line

Answers Key

Course Code: ELE1305 , Course Name: Introduction to Power System
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. III Semester, End-Sem. Examination

Distribution transformer



4. What is Circuit Breaker? Explain the working principle of Circuit Breaker

A circuit breaker is a switching device that interrupts the abnormal or fault current. It is a mechanical device that disturbs the flow of high magnitude (fault) current and in additions performs the function of a switch. The circuit breaker is mainly designed for closing or opening of an electrical circuit, thus protects the electrical system from damage.

Working Principle of Circuit Breaker

Circuit breaker essentially consists of fixed and moving contacts. These contacts are touching each other and carrying the current under normal conditions when the circuit

is closed. When the circuit breaker is closed, the current carrying contacts, called the electrodes, engaged each other under the pressure of a spring.

During the normal operating condition, the arms of the circuit breaker can be opened or closed for a switching and maintenance of the system. To open the circuit breaker, only a pressure is required to be applied to a trigger.

Section – C

04X06 = 24 Marks

1. Compare overhead Transmission conductors with Underground transmission cables

Construction

Underground cables are more expensive to construct since they have to be electrically insulated and have protection against moisture, corrosion, mechanical damage and other environmental impacts from the soil. Construction of the cables is more complicated compared to the overhead cables which are simple to construct, and do not require insulation and sheathing. The overhead cables have lesser requirements and cheaper to construct.

Installation

The installation of overhead lines on poles is easier and straightforward. However, the underground cables require digging trenches and this may be complicated by other utility service lines such as water pipes, oil and gas pipelines, sewer lines. Other complications may arise due to rocks, loose soil and water along the routes, making them more expensive to install.

Heat dissipation

Heat dissipation in underground cables is limited by the layers of insulation and protection such as armoring and sheaths. Most of the heat is therefore retained near the cable unlike the overhead cables where most of the heat is released to the surrounding and automatic natural cooling is provided by the air.

Size of Conductors

Underground cables have larger conductor sizes compared to overhead lines for the same amount of power. This is due to the fact that the overhead lines have a natural cooling and hence the ability to carry more power without heating up.

Voltage carrying capacity

The overhead lines are better suited to carry higher voltages compared to the underground cables, which are limited by the expensive construction and limited heat dissipation. For these reasons, the underground cables are mostly used for transmitting up to 33KV.

Fault detection and repair

It is easier to detect and repair faults in overhead cables. It is more complicated and takes more time to locate and repair the underground systems.

Public safety

Underground cables are safer to the public, animals and environment compared to the overhead lines i.e. there are no issues such as people getting in contact with fallen lines. The overhead cables can be brought down and human, animal intervention, weather as well vegetation such as trees.

The underground cables are less impacted by these conditions and not affected by trees, animals, accidents, wind, storms and other physical interference that may lead to broken poles and short circuits or cable breakages.

Effect of lightning discharges

Overhead cables are more prone to lightning strikes whereas the underground cables are not affected by the discharges.

Interference

Overhead lines interfere with communication lines that are in close proximity, have corona discharge, radio and TV interference which does not happen with the underground lines.

2. Write down the short note on :

Conventional and Non Conventional Sources of energy

Conventional sources of energy can be described as non-renewable sources of energy which have been used since a long time.Conventional sources of energy are used extensively by mankind and the magnitude of usage is so high that the reserves have got depleted to a great extent. Example: Coal, petroleum, natural gas

Non conventional sources of energy are mostly renewable or available in abundance on earth. They are ecologically safe to use as well. Example: wind/ solar/ hydro/ geothermal energy

Pin type and Suspension type insulator A **pin insulator** consists of a non-conducting material such as porcelain, glass, plastic, polymer, or wood.

- As the name suggests, the pin type insulator is secured to the cross-arm on the pole.
- There is a groove on the upper end of the insulator for housing the conductor.
- The conductor passes through this groove and is bound by the annealed wire of the same material as the conductor.
- Pin type insulators are used for transmission and distribution of electric power at voltages upto 33 kV.
- Beyond operating voltage of 33 kV, the pin type insulators become too bulky and hence uneconomical

(b) Suspension Type Insulators

- For high voltages (>33 kV), it is a usual practice to use suspension type insulators consist of a number of porcelain discs connected in series by metal links in the form of a string.
- The conductor is suspended at the bottom end of this st ring while the other end of the string is secured to the cross-arm of the tower.
- Each unit or disc is designed for low voltage, say 11 kV.
- The number of discs in series would obviously depend upon the working voltage.
- For instance, if the working voltage is 66 kV, then six discs in series will be provided on the string.

(c) Current Transformer and Potential Transformer.

CT is a type of instrument transformer that is used in power system for measurement, detection, protection of the system. Current transformers are used extensively for measuring current and monitoring the operation of the power grid.

Potential transformers are instrument transformers. They have a large number of primary turns and a few number of secondary turns. It converts voltages from high to low. It will take the thousands of volts behind power transmission systems and step the voltage down to something that meters can handle.

3. Write down in detail the advantages and disadvantages of SF6 Circuit Breaker

Advantage of SF6 circuit breaker

- SF6 gas has excellent insulating, arc extinguishing and many other properties which are the greatest advantages of SF6 circuit breakers.
- The gas is non-inflammable and chemically stable. Their decomposition products are non-explosive and hence there is no risk of fire or explosion.
- Electric clearance is very much reduced because of the high dielectric strength of SF6.
- Its performance is not affected due to variations in atmospheric condition.
- It gives noiseless operation, and there is no over voltage problem because the arc is extinguished at natural current zero.
- There is no reduction in dielectric strength because no carbon particles are formed during arcing.
- It requires less maintenance and no costly compressed air system is required.
- SF6 performs various duties like clearing short-line faults, switching, opening unloaded transmission lines, and transformer reactor, etc. without any problem.

Disadvantages of SF6 circuit breakers

- SF6 gas is suffocating to some extent. In the case of leakage in the breaker tank, the SF6 gas being heavier than air and hence SF6 are settled in the surroundings and lead to the suffocation of the operating personnel.
- The entrance of moisture in the SF6 breaker tank is very harmful to the breaker, and it causes several failures.
- The internal parts need cleaning during periodic maintenance under clean and dry environment.
- The special facility requires for transportation and maintenance of quality of gas.

4. How Corona Effect and Ferranti effect can be reduced in transmission line?

Corona decreases the efficiency of transmission lines. Therefore, it is necessary to minimize corona. The following factors may be considered to control corona:

Conductor diameter – For reducing corona loss, this method of increasing conductor diameters is very effective. Diameters of conductors can be increased by using hollow conductors and by using steel-cored aluminum conductors(ACSR) conductors.

The voltage of the line – Voltage of transmission lines is fixed by economic considerations. To increase the disruptive voltage the spacing of the conductors is to be increased, but this method has some limitations.

Spacing between conductors – If the space between conductors increases, then the voltage drops between them also increases due to increase in inductive reactance.

Electrical devices are designed to work at some particular voltage. If the voltages are high at the user ends their equipment get damaged, and their windings burn because of high voltage. Ferranti effect on long transmission lines at low load or no load increases the receiving end voltage.

This voltage can be controlled by placing the shunt reactors at the receiving end of the lines.

Shunt reactor is an inductive current element connected between line and neutral to compensate the capacitive current from transmission lines. When this effect occurs in long transmission lines, shunt reactors compensate the capacitive VAr of the lines and therefore the voltage is regulated within the prescribed limits.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Electrical Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, III Semester,

End-Sem. Examination

Course Code: ELE 1305 **Time: 2 Hours**

Course Name: Introduction to Power System **Max. Marks: 50**

Instruction: Answer all questions from each and every section. Section A, each question carries one mark, section B, each question carries four marks and in section C, each question carries six marks. Scientific calculator is allowed.

Section – A

10X01 = 10 Marks

1. Why Ferranti effect cannot occur in the Short Transmission line.
   (a) Due to absence of Capacitance (c) Due to absence of resistance
   (b) Due to absence of Inductance (d) All of the above
2. Coal, Diesel, Natural gas and oil is example of:
   a) Conventional Source of Energy
   b) Non- Conventional Source of Energy
   c) Renewable Source of Energy
   d) None of the above
3. When voltage level is between 345KV- 765KV than it is known as
   (a) High voltage (c) Ultra High Voltage
   (b) Extra High Voltage (d) Medium Voltage
4. "Inductance, capacitance, phase displacement and surge problems can be eliminated in DC system". This statement is True or False?
   (a) True (b) False
5. Oil or SF6 in a Circuit Breakers are used to:
   (a) For making contacts (c) For breaking contacts
   (b) For quenching the arc (d) None of the above
6. A electromechanical relay works on the principle of.
   (a) Mutual Induction (c) Lenz Law
   (b) Electromagnetic Induction (d) All of the above
7. Up to 33KV which type of insulator is preferred
   (a) Suspension Type (c) Shackle
   (b) Pin type (d) Strain Type
8. For a 440kV line what will be the number of disc in a suspension type insulator
   (a) ~10 (b) ~40 (c) ~20 (d) None of them
9. Potential Transformer is connected in..... with the power lines. Fill in the blank.
   (a) Series (c) Parallel
   (b) Can be connected either series of parallel (d) None of the above
10. To convert water into steam which component is used in Thermal Power Plant
    (a) Boiler (b) Draft Fan (c) Condenser (d) None of them

Set B

Section – B

1. Draw the neat and clean diagram of Hydro Power Plant and Explain its working .
2. Explain the following:
   (a) HV/DC transmission (b) Transmission Substation (c) Skin Effect (d) Relay
3. What do you understand by Power System and What are its main component? Draw a single line diagram power system using all these components
4. What is Circuit Breaker? Explain the working principle of Circuit Breaker

Section – C

04X06 = 24 Marks

1. Compare overhead Transmission conductors with Underground transmission cables
2. Write down the short note on :
   (a) Conventional and Non Conventional Sources of energy
   (b) Pin type and Suspension type insulator
   (c) Current Transformer and Potential Transformer.
3. Write down in detail the advantages and disadvantages of SF6 Circuit Breaker
4. How Corona Effect and Ferranti effect can be reduced in transmission line

Answers Key

Course Code: ELE1305 , Course Name: Introduction to Power System
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. III Semester, End-Sem. Examination

SECTION A

1. (d) All of the above
2. (b) Non- Conventional Source of Energy
3. (c) Ultra High Voltage
4. (b) False
5. (c) Electromagnet
6. (a) Sulphur Hexafluoride
7. (d) All of the above
8. (c) ~20
9. (a) Series
10. (c) Condenser

Section – B

04X04 = 16 Marks

1. Define Generating Substation and Transmission Substation.

Answer: Transmission Substation: The transmission substation carries the overhead lines which transfer the generated electrical energy from generation to the distribution substations.

The transmission lines mainly perform the two functions

1. It transports the energy from generating stations to bulk receiving stations.
2. It interconnects the two or more generating stations. The neighbouring substations are also interconnected through the transmission lines.

The transmission voltage is operating at more than 66KV and is standardised at 69KV, 115KV, 138KV, 161KV, 230KV, 345KV, 500KV, and 765KV, line-to-line. The transmission line above 230KV is usually referred to as extra high voltage (EHV).

Generating Substation: In generating station the fuel (coal, water, nuclear energy, etc.) is converted into electrical energy. The electrical power is generated in the range of 11kV to 25kV, which is step-up for long distance transmission.

The generator and the transformer are the main components of the generating station.

The generator converts the mechanical energy into electrical energy.

The transformer transfers the power with very high efficiency from one level to another. The power transfer from the secondary is approximately equal to the primary except for losses in the transformer. The step-up transformer will reduce losses in the line which makes the transmission of power over long distances.

2. Explain the working of following components

(a) **Superheater-** The superheater is one component in the boiler that serves to further heat the steam to produce steam that meets the requirements for turning turbines.The superheater is a collection of boiler pipes located in the flow of hot gas from combustion. The heat from this gas is transferred to Saturated Steam in the superheater pipe, so it turns into superheated steam.

(b) **Economizer-** Function of economiser in thermal power plant is to recover some of the heat from the heat carried away in the flue gases up the chimney and utilize for heating the feed water to the boiler. It is simply a heat ex-changer with hot flue gas on shell side and water on tube side with extended heating surface like Fins or Gills.

(c) **Condenser-** The surface condenser is a shell and tube heat exchanger where cooling water flows through tubes and exhaust steam fed into the shell surrounds the tubes. as a result, steam condense outside the tubes.

(d) Boiler The function of boiler is to generate steam at desired pressure and temperature by transferring heat produced by burning of fuel in a furnace to change water into steam.

3. What should be the properties of a good insulator? What are the advantages of glass insulators over porcelain insulators?

Answer: Following should be properties of good isulators

- high mechanical strength in order to withstand the conductor load, wind load etc.
- high electrical resistance in order to minimize the leakage currents.
- high relative permittivity of insulating material so that the dielectric strength is high
- high ratio of puncture strength to flashover.

Advantages of glass insulators over porcelain insulators

- Its resistivity is also very high.
- It has low coefficient of thermal expansion.
- It has higher tensile strength compared to porcelain insulator.
- As it is transparent in nature, it is not heated up in sunlight as porcelain.
- The impurities and air bubble can be easily detected inside.
- Glass has very long service life as because mechanical and electrical properties of glass do not be affected by ageing.
- After all, glass is cheaper than porcelain.
- It has very high dielectric strength compared to porcelain.

4. What is relay? Explain the working principle of relay

Relays generally refer to electromagnetic relays, which are mechanical actions. The essence of the relay is to use a loop (usually a small current) to control the on and off of another loop (generally a large current), and in this control process, the two loops are generally isolated, and its basic principle is to utilize The electromagnetic effect is used to control the mechanical contact to achieve the purpose of switching, and the core coil is energized - the coil current generates a magnetic field - the magnetic field absorbs the armature action switching contact, and the whole process is "small current - magneto-mechanical - large current" a process.

The relay has a normally open contact and a normally closed contact. The movable contact is a common end. This is a DC relay, that is, when the relay coil passes DC power the coil with iron core will output the corresponding magnetic field, the armature will be attracted, and the moving contact will run from the normally closed contact side to the normally open contact side, which is equivalent to the normally open contact. It is. From the figure, the start/stop button, the battery, and the relay coil form a control loop. As long as this loop is engaged, the coil will have a current through it and a magnetic field will be generated.

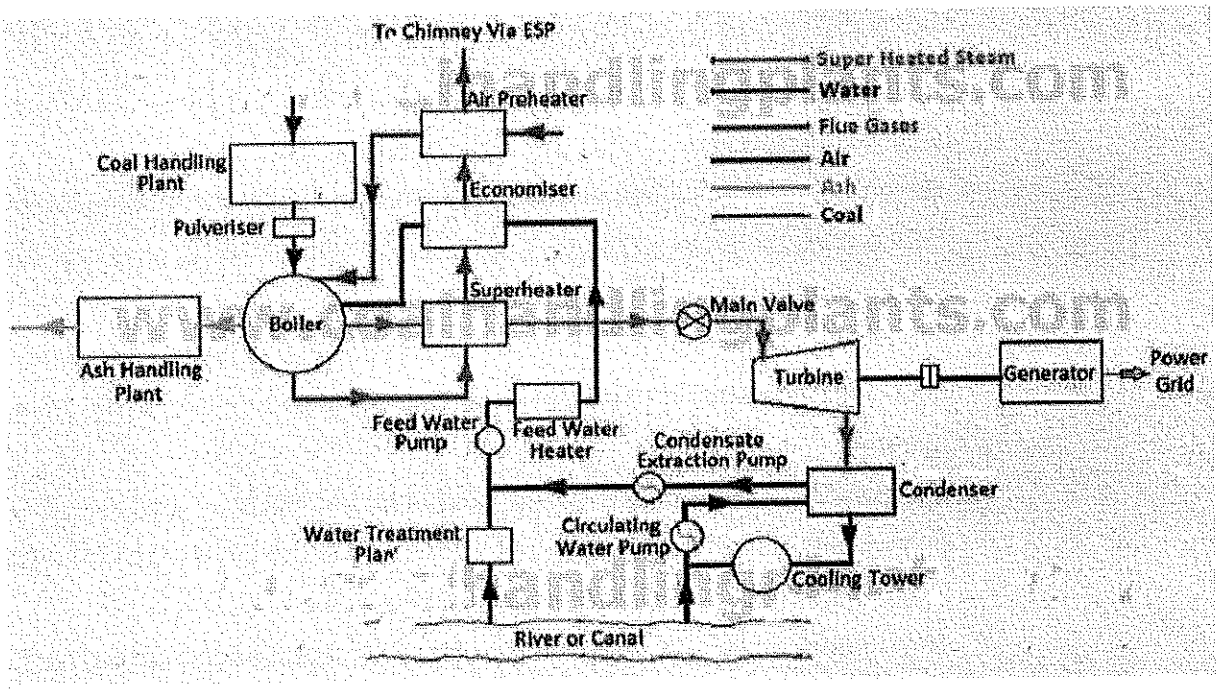
The normally open contact, the bulb, and the control power supply of another bulb (the other battery on the figure) form a loop. When the normally open contact is closed, the

loop is closed and the current will be from the control power supply. The positive end, flowing through the bulb, passes through the closed normally open contact and then back to the negative pole so that the bulb will illuminate.

Section – C

04X06 = 24 Marks

1. Draw the neat and clean diagram of Thermal Power Plant and Explain its working



- Firstly the water is taken into the boiler from a water source. The boiler is heated with the help of coal.
- The increase in temperature helps in the transformation of water into steam. The steam generated in the boiler is sent through a steam turbine.
- The turbine has blades that rotate when high velocity steam flows across them. This rotation of turbine blades is used to generate electricity.
- A generator is connected to the steam turbine. When the turbine turns, electricity is generated and given as output by the generator, which is then supplied to the consumers through high-voltage power lines.

2. **Write down the short note on :**

Conventional and Non Conventional Sources of energy

Conventional sources of energy can be described as non-renewable sources of energy which have been used since a long time.Conventional sources of energy are

used extensively by mankind and the magnitude of usage is so high that the reserves have got depleted to a great extent. Example: Coal, petroleum, natural gas

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- As the name suggests, the pin type insulator is secured to the cross-arm on the pole.
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- For instance, if the working voltage is 66 kV, then six discs in series will be provided on the string.

(c) Current Transformer and Potential Transformer.

CT is a type of instrument transformer that is used in power system for measurement, detection, protection of the system. Current transformers are used extensively for measuring current and monitoring the operation of the power grid.

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Answers Key

Course Code: ELE1305 , Course Name: Introduction to Power System
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B. Voc. III Semester, End-Sem. Examination

3. **Write down in detail the advantages of DC transmission over AC transmission system.**

- Answer- Only two conductors are required for DC transmission system. It is further possible to use only one conductor of DC transmission system if the earth is utilized as the return path of the system.
- The potential stress on the insulator of the DC transmission system is about 70% of the equivalent voltage AC transmission system. Hence, DC transmission systems have reduced insulation costs.
- Inductance, capacitance, phase displacement and surge problems can be eliminated in DC system.
- The volume of conductor required in AC systems is much higher when compared to DC systems.
- The reactance of the line affects the voltage regulation of the electrical power transmission system.
- Problems of skin effects and proximity effects only found in AC systems.
- AC transmission systems are more likely to be affected by corona discharge than a DC transmission system.
- Construction of AC electrical power transmission network is more completed than DC systems.
- Proper synchronizing is required before interconnecting two or more transmission lines together, synchronizing can totally be omitted in DC transmission system.

4. Explain in details about the four types of feeders used in distribution system.

Radial Feeders It is used for many distribution processes it is really cheap and simple it is only used when the substation or the generating stations are located at the center of the consumers in this type feeder will radiate from the generating stations or substations and it will reach the distributors at one end. Thus the power flow is in one direction. Although this system is simplest and least expensive, it is not highly reliable. A major **drawback of a radial distribution system** is, a fault in the feeder will result in supply failure to associated consumers as there won't be any alternative feeder to feed distributors.

Parallel feeder

There is a disadvantage in radial feeders if there is any fault occur during the transmission there will be no supply for many customers so this can be changed by

using parallel feeder if there is any fault occurs only one line of the feeder will be affected the other will do the work the cost is high due to increase in feeder number it can be used to transfer heavy loads

Ring Main

In this type of feeder system, we could get reliability as much as in a parallel system This type of feeders are used in urban and industrial environment in this type the distribution transformers are connected with two feeders cabling has done for many routes starting and finishing is in the same location the power is delivered to the substations if there is any fault In the ring it will be isolated by circuit breaker and the supply will continue by using ring feeder there will be few fluctuations in the customer section there is always an alternative path if any fault occurs.

Interconnected Feeder

In this type the ring feeder is energized by more than one substation or generating station it is an interconnected distribution in case of transmission failure the system doesn't stop it continues and it does the load transmission

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.:.....

School of Electrical Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, 3rd Semester,

End-Sem. Examination

Course Code: ELE-1306 **Time: 2 Hour**

Course Name: Electrical Machines – I **Max. Marks: 50**

Instruction: Answer all questions from section A, each question carries one mark. Answer all questions from section B, each question carries four marks. Answer all questions from section C, each question carries six marks. Scientific calculator is allowed.

Section – A

10X10 = 10 Marks

1. The yoke of a DC machine is made of
   a) Silicon steel
   b) Soft iron
   c) Aluminium
   d) Cast steel
2. The real working part of a DC machine is the
   a) Commutator
   b) Field winding
   c) Armature winding
   d) None of the above
3. A separately excited DC generator is not used because
   a) It is costly
   b) Separate DC source is required for field circuit
   c) Voltage drops considerably with load
   d) None of the above
4. The main draw back of a DC shunt generator is that
   a) Terminal voltage drops considerably with load
   b) Shunt field circuit has high resistance
   c) Generated voltage is small
   d) It is expensive
5. A DC motor is used to
   a) Generate power
   b) Change mechanical energy into electrical energy
   c) Change electrical energy into mechanical energy
   d) Increase energy put into it
6. Carbon brushes are preferable to copper brushes because
   a) They have longer life
   b) They reduce armature reaction
   c) They have lower resistance
   d) They reduce sparking
7. A transformer will work on
   a) AC only
   b) DC only
   c) AC as well as DC
   d) None of the above
8. The primary and secondary of a transformer are .....coupled.
   a) Electrically
   b) Magnetically
   c) Electrically and magnetically

Set-A

d) None of the above

9. A single phase induction motor employs…
   a) Squirrel cage
   b) Wound
   c) Either squirrel cage and wound
   d) None of the above
10. Most of single phase induction motors are.. machines.
   a) 2-pole
   b) 6-pole
   c) 8-pole
   d) 4-pole

Section – B

04X04 = 16 Marks

1. What is back E.M.F or counter E.M.F?
2. How to make Single-Phase Induction Motor Self-Starting?
3. Explain briefly the important characteristics of a d.c. generator.
4. Explain the operation of Shaded-pole motor.

Section – C

04X06 = 24 Marks

1. What is DC Motor and explain the construction of DC motor.
2. What is transformer and explain the working of transformer.
3. Explain the principle and construction of DC generator.
4. Drive the EMF equation of DC generator.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.:.....

School of Electrical Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, 3rd Semester,

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d) 4-pole

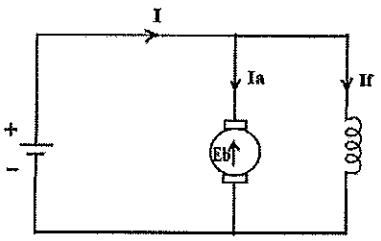
Section – B

04X04 = 16 Marks

Note: each question carries 04 marks.

1. What is back E.M.F or counter E.M.F?

Solution: According to the fundamental law of nature, no energy conversion is possible until there is something to oppose the conversion. In case of generators, magnetic drag provides this opposition, but in the case of dc motors, there is back emf. Presence of the back emf makes a dc motor 'self-regulating'.



When the armature of a motor is rotating, the conductors are also cutting the magnetic flux lines and hence according to the Faraday's law of electromagnetic induction, an emf induces in the armature conductors.

The direction of this induced emf is such that it opposes the armature current (I_a). The circuit diagram below illustrates the direction of the back emf and armature current.

Significance of Back-EMF

Magnitude of back emf is directly proportional to speed of the motor. Consider the load on a dc motor is suddenly reduced. In this case, required torque will be small as compared to the current torque. Speed of the motor will start increasing due to the excess torque. Hence, being proportional to the speed, magnitude of the back emf will also increase. With increasing back emf armature current will start decreasing. Torque being proportional to the armature current, it will also decrease until it becomes sufficient for the load. Thus, speed of the motor will regulate.

On the other hand, if a dc motor is suddenly loaded, the load will cause decrease in the speed. Due to decrease in speed, back emf will also decrease which allows more armature current. Due to increase in armature current the torque will increase to fulfill the load requirement.

2. How to make Single-Phase Induction Motor Self-Starting?

Ans: The single-phase induction motor is not self- starting and it is undesirable to resort to mechanical spinning of the shaft or pulling a belt to start it. To make a single-phase induction motor self-starting, we should somehow produce a revolving stator magnetic field. This may be achieved by converting a single-phase supply into two-phase supply through the use of an additional winding. When the motor attains sufficient speed, the starting means (i.e., additional winding) may be removed depending upon the type of the motor.

3. Explain briefly the important characteristics of a d.c. generator.

Ans: The following are the three most important characteristics of a d.c. generator:

1. Open Circuit Characteristic (O.C.C.)

This curve shows the relation between the generated e.m.f. at no-load (E0) and the field current (If) at constant speed. It is also known as magnetic characteristic or no-load saturation curve. Its shape is practically the same for all generators whether separately or self-excited. The data for O.C.C. curve are obtained experimentally by

operating the generator at no load and constant speed and recording the change in terminal voltage as the field current is varied.

2. Internal or Total characteristic (E/Ia)

This curve shows the relation between the generated e.m.f. on load (E) and the armature current (Ia). The e.m.f. E is less than E0 due to the demagnetizing effect of armature reaction. Therefore, this curve will lie below the open circuit characteristic (O.C.C.). The internal characteristic is of interest chiefly to the designer. It cannot be obtained directly by experiment. It is because a voltmeter cannot read the e.m.f. generated on load due to the voltage drop in armature resistance. The internal characteristic can be obtained from external

characteristic if winding resistances are known because armature reaction effect is included in both characteristics.

3. External characteristic (V/IL)

This curve shows the relation between the terminal voltage (V) and load current (IL). The terminal voltage V will be less than E due to voltage drop in the armature circuit. Therefore, this curve will lie below the internal characteristic. This characteristic is very important in determining the suitability of a generator for a given purpose. It can be obtained by making simultaneous measurements of terminal voltage and load current (with voltmeter and ammeter) of a loaded generator.

4. Explain the operation of Shaded-pole motor.

Ans: **Shaded-Pole Motor**

The shaded-pole motor is very popular for ratings below 0.05 H.P. (~ 40 W) because of its extremely simple construction. It has salient poles on the stator excited by single-phase supply and a squirrel cage rotor as shown in Fig. (9.16).

A portion of each pole is surrounded by a short-circuited turn of copper strip called shading coil.

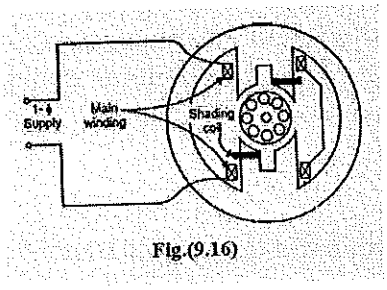


Fig.(9.16)

Operation

The operation of the motor can be understood by referring to Fig. (9.17) which shows one pole of the motor with a shading coil.

(i) During the portion OA of the alternating-current cycle [See Fig. (9.17)], the flux begins to increase and an e.m.f. is induced in the shading coil. The resulting current in the shading coil will be in such a direction (Lenz's law) so as to oppose the change in flux. Thus the flux in the shaded portion of the pole is weakened while that in the unshaded portion is strengthened as shown in Fig. (9.17 (ii)).

(ii) During the portion AB of the alternating-current cycle, the flux has reached almost maximum value and is not changing. Consequently, the flux distribution across the pole is uniform [See Fig. (9.17 (iii))] since no current is flowing in the shading coil. As the flux decreases (portion BC of the alternating current cycle), current is induced in the shading coil so as to oppose the decrease in current. Thus the flux in the shaded portion of the pole is strengthened while that in the unshaded portion is weakened as shown in Fig. (9.17 (iv)).

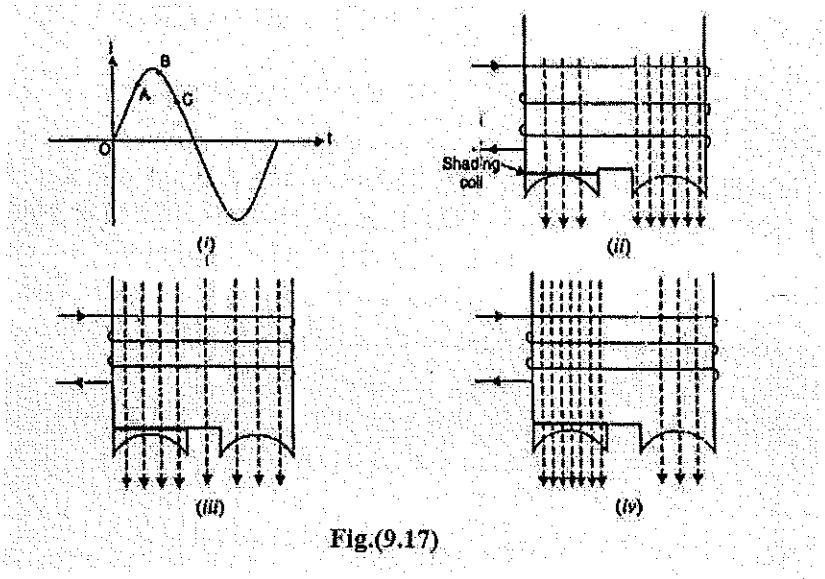


Fig.(9.17)

(iii) The effect of the shading coil is to cause the field flux to shift across the pole face from the unshaded to the shaded portion. This shifting flux is like a rotating weak field moving in the direction from unshaded portion to the shaded portion of the pole.
(iv) The rotor is of the squirrel-cage type and is under the influence of this moving field. Consequently, a small starting torque is developed. As soon as this torque starts to revolve the rotor, additional torque is produced by single-phase induction-motor action. The motor accelerates to a speed slightly below the synchronous speed and runs as a single-phase induction motor.

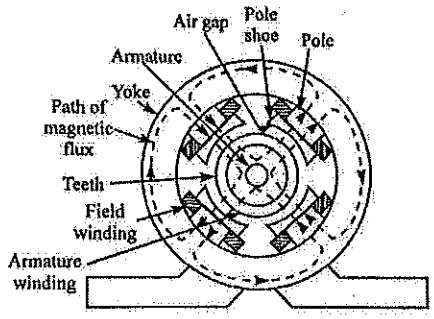
Section – C

04X06 = 24 Marks

Note: each question carries 06 marks.

1. **What is DC Motor and explain the construction of DC motor.**

Ans: The DC motor is the motor which converts the direct current into the mechanical work. It works on the principle of Lorentz Law, which states that "the current carrying conductor placed in a magnetic and electric field experience a force". And that force is the Lorentz force.



Construction of DC Motor

Before understanding the working of DC motor first, we have to know about their construction. There are two main parts of the DC motor.

- Armature
- Stator

The rotating part is the armature and the Stator is their stationary part. The armature coil is connected to the DC supply.

The armature coil consists the commutators and brushes. The commutator converts the AC induces in the armature into DC and brushes transfer the current from rotating part of the motor to the stationary external load. The armature places between the north and south pole of the permanent or electromagnet.

PARTS OF THE STATOR:-

YOKE:

The yoke or outer frame provides coverage to a dc motor. It is made up of **cast steel** for large dc motors. And of **cast iron** for small dc motors. The yoke is used in DC machine because:

A) It provides mechanical support to poles.
B) Acts as a protective cover against mechanical damage.

C) And provides a passage for the magnetic flux produced by the poles of the machine.

POLE CORE AND POLE SHOE:

Both pole core and pole shoes are made of cast steel. But pole shoes are laminated as they are close to the armature.

If the load changes during the operation of the DC motor, the armature current changes. As a result the magnetic flux also changes. This flux links the pole shoe and causes **eddy current** to flow. And to minimize these eddy currents, pole shoes are laminated.

The main purpose of the pole shoe is to spread the flux and reduce the reluctance of the magnetic path. Whereas the pole core is excited with field winding and used to support them.

POLE WINDING OR FIELD COILS

The pole winding and field coils consist of copper wire placed in position around the pole core. When current passes through these coils, they electro-magnetize the pole which produces the magnetic flux. This flux passes through the rotor and produces a rotating torque as soon as the current starts flowing in the armature of the rotor.

PARTS OF THE ROTOR:-

ARMATURE CORE

The armature core is the rotating part of a DC/AC machine. It is made up of **silicon steel**. The cylindrical structure is laminated to reduce the eddy current loss. Its main purpose is to offer a low reluctance path to the magnetic flux. And to house the armature conductors.

ARMATURE WINDING

Armature winding is composed of coils embedded in armature core slots. These coils are lined next to each other with tough insulating material. The insulating material prevents the two adjacent coils from a short circuit.

Whereas the slot insulation is folded over the armature conductor and is secured firmly by wood or Fibre wedges. In simple words, it is an arrangement of current-carrying conductors that produce EMF in the machine due to relative motion between the windings and the main field.

COMMUTATOR

The commutator contains wedge-shaped hard drawn copper segments, forming a cylindrical structure. A thin sheet of **high-quality mica** insulates the segments from each other.

A commutator periodically changes the direction of the current between the rotor and external circuit. Hence, it acts as a switch causing a unidirectional torque in the dc motor.

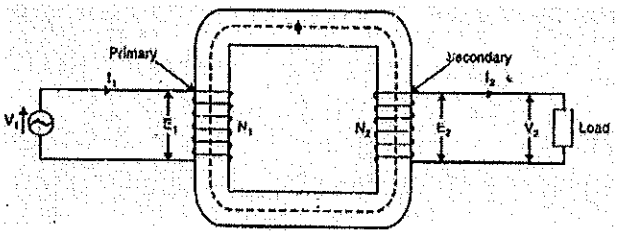
BRUSHES

Brushes are usually made of rectangular carbon blocks housed in brush holders. The function of brushes in DC motors is to supply the current to the commutator from an external dc source.

Whereas the function of the brushes in a **DC generator** is to collect the current from the commutator and supply it to the external load circuit.

2. What is transformer and explain the working of transformer.

Ans: A transformer is a static piece of equipment used either for raising or lowering the voltage of an a.c. supply with a corresponding decrease or increase in current. It essentially consists of two windings, the primary and secondary, wound on a common laminated magnetic core as shown in Fig. The winding connected to the a.c. source is called primary winding (or primary) and the one connected to load is called secondary winding (or secondary). The alternating voltage V1 whose magnitude is to be changed is applied to the primary. Depending upon the number of turns of the primary (N1) and secondary (N2), an alternating e.m.f. E2 is induced in the secondary. This induced e.m.f. E2 in the secondary causes a secondary current I2. Consequently, terminal voltage V2 will appear across the load. If V2 > V1, it is called a step up-transformer. On the other hand, if V2 < V1, it is called a step-down transformer.



Working

When an alternating voltage V1 is applied to the primary, an alternating flux f is set up in the core. This alternating flux links both the windings and induces e.m.f.s E1 and E2 in them according to Faraday's laws of electromagnetic induction. The e.m.f. E1 is termed as primary e.m.f. and e.m.f. E2 is termed as secondary e.m.f.

Clearly, $E_1 = -N_1 \frac{d\phi}{dt}$

and $E_2 = -N_2 \frac{d\phi}{dt}$

$\therefore \quad \frac{E_2}{E_1} = \frac{N_2}{N_1}$

Note that magnitudes of E2 and E1 depend upon the number of turns on the secondary and primary respectively. If N2 > N1, then E2 > E1 (or V2 > V1) and we get a step-up transformer. On the other hand, if N2 < N1, then E2 < E1 (or V2 < V1) and we get a step-down transformer. If load is connected across the secondary winding, the secondary e.m.f. E2 will cause a current I2 to flow through the load. Thus, a transformer enables us to transfer a.c. power from one circuit to another with a change in voltage level.

The following points may be noted carefully:

(i) The transformer action is based on the laws of electromagnetic induction.

(ii) There is no electrical connection between the primary and secondary.
The a.c. power is transferred from primary to secondary through magnetic flux.

(iii) There is no change in frequency i.e., output power has the same frequency as the input power.

(iv) The losses that occur in a transformer are:

(a) core losses—eddy current and hysteresis losses

(b) copper losses—in the resistance of the windings

In practice, these losses are very small so that output power is nearly equal to the input primary power. In other words, a transformer has very high efficiency.

3. Explain the principle and construction of DC generator.

Ans: Generator Principle

An electric generator is a machine that converts mechanical energy into electrical energy. An electric generator is based on the principle that whenever flux is cut by a conductor, an e.m.f. is induced which will cause a current to flow if the conductor circuit is closed. The direction of induced e.m.f. (and hence current) is given by Fleming's right hand rule. Therefore, the essential components of a generator are:

(a) a magnetic field

(b) conductor or a group of conductors

(c) motion of conductor w.r.t. magnetic field.

Construction of d.c. Generator

The d.c. generators and d.c. motors have the same general construction. In fact, when the machine is being assembled, the workmen usually do not know whether it is a d.c. generator or motor. Any d.c. generator can be run as a d.c. motor and vice-versa. All d.c. machines have five principal components viz., (i) field system (ii) armature core (iii) armature winding (iv) commutator (v) brushes [See Fig. 1.7].

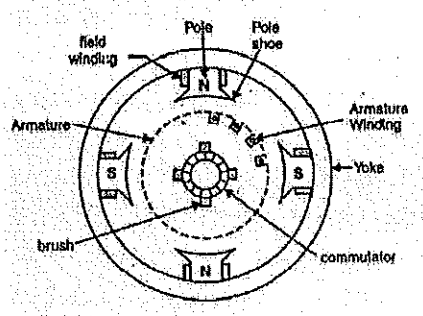


Fig. (1.7)

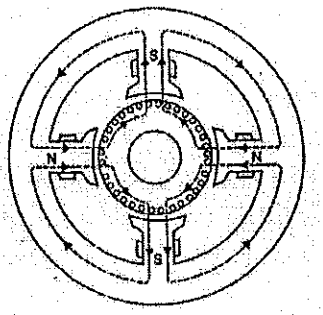


Fig. (1.8)

(i) Field system

The function of the field system is to produce uniform magnetic field within which the armature rotates. It consists of a number of salient poles (of course, even number) bolted to the inside of circular frame (generally called yoke). The yoke is usually made of solid cast steel whereas the pole pieces are composed of stacked laminations. Field coils are mounted on the poles and carry the d.c. exciting current. The field coils are connected in such a way that adjacent poles have opposite polarity.

The m.m.f. developed by the field coils produces a magnetic flux that passes through the pole pieces, the air gap, the armature and the frame (See Fig. 1.8). Practical d.c. machines have air gaps ranging from 0.5 mm to 1.5 mm. Since armature and field systems are composed of materials that have high permeability, most of the m.m.f. of field coils is required to set up flux in the air gap. By reducing the length of air gap, we can reduce the size of field coils (i.e. number of turns).

(ii) Armature core

The armature core is keyed to the machine shaft and rotates between the field poles. It consists of slotted soft-iron laminations (about 0.4 to 0.6 mm thick) that are stacked to form a cylindrical core as shown in Fig (1.9). The laminations (See Fig. 1.10) are individually coated with a thin insulating film so that they do not come in electrical contact with each other. The purpose of laminating the core is to reduce the eddy current loss. The laminations are slotted to accommodate and provide mechanical security to the armature winding and to give shorter air gap for the flux to cross between the pole face and the armature "teeth".

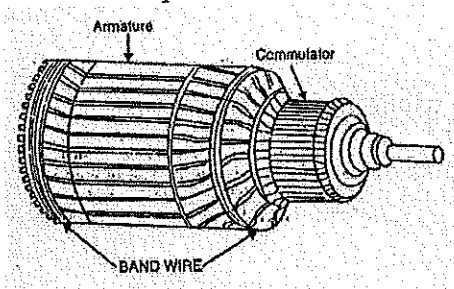


Fig. (1.9)

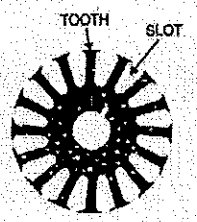


Fig. (1.10)

(iii) Armature winding

The slots of the armature core hold insulated conductors that are connected in a suitable manner. This is known as armature winding. This is the winding in which "working" e.m.f. is induced. The armature conductors are connected in series-parallel; the conductors being connected in series so as to increase the voltage and in parallel paths so as to increase the current. The armature winding of a d.c. machine is a closed-circuit winding; the conductors being connected in a symmetrical manner forming a closed loop or series of closed loops.

(iv) Commutator

A commutator is a mechanical rectifier which converts the alternating voltage generated in the armature winding into direct voltage across the brushes. The

commutator is made of copper segments insulated from each other by mica sheets and mounted on the shaft of the machine (See Fig 1.11). The armature conductors are soldered to the commutator segments in a suitable manner to give rise to the armature winding. Depending upon the manner in which the armature conductors are connected to the commutator segments, there are two types of armature winding in a d.c. machine viz., (a) lap winding (b) wave winding. Great care is taken in building the commutator because any eccentricity will cause the brushes to bounce, producing unacceptable sparking. The sparks may bum the brushes and overheat and carbonise the commutator.

(v) Brushes

The purpose of brushes is to ensure electrical connections between the rotating commutator and stationary external load circuit. The brushes are made of carbon and rest on the commutator. The brush pressure is adjusted by means of adjustable springs (See Fig. 1.12). If the brush pressure is very large, the friction produces heating of the commutator and the brushes. On the other hand, if it is too weak, the imperfect contact with the commutator may produce sparking.

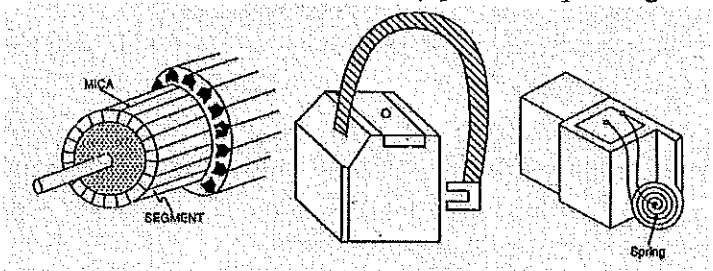


Fig. (1.11) Fig. (1.12)

Multipole machines have as many brushes as they have poles. For example, a 4-pole machine has 4 brushes. As we go round the commutator, the successive brushes have positive and negative polarities. Brushes having the same polarity are connected together so that we have two terminals viz., the +ve terminal and the -ve terminal.

4. Drive the EMF equation of DC generator.

Ans: E.M.F. Equation of a D.C. Generator

We shall now derive an expression for the e.m.f. generated in a d.c. generator.

Let f = flux/pole in Wb

Z = total number of armature conductors

P = number of poles

A = number of parallel paths = 2 ... for wave winding

= P ... for lap winding

N = speed of armature in r.p.m.

Eg = e.m.f. of the generator = e.m.f./parallel path

Flux cut by one conductor in one revolution of the armature,

$$d\phi = P\phi \text{ webers}$$

Time taken to complete one revolution,

$$dt = 60/N \text{ second}$$

$$\text{e.m.f generated/conductor} = \frac{d\phi}{dt} = \frac{P\phi}{60/N} = \frac{P\phi N}{60} \text{ volts}$$

e.m.f. of generator,

E_g = e.m.f. per parallel path

= (e.m.f/conductor) × No. of conductors in series per parallel path

$$= \frac{P\phi N}{60} \times \frac{Z}{A}$$

$$\therefore \quad E_g = \frac{P\phi ZN}{60A}$$

where A = 2 for-wave winding

= P for lap winding

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.:.....

School of Electrical Skills (ELE)

Session: 2021-22 (Summer Semester)

B. Voc. Program, 3rd Semester,

End-Sem. Examination

Course Code: ELE-1306 **Time: 2 Hour**

Course Name: Electrical Machines – I **Max. Marks: 50**

Instruction: Answer all questions from section A, each question carries one mark. Answer all questions from section B, each question carries four marks. Answer all questions from section C, each question carries six marks. Scientific calculator is allowed.

Section – A

10X01 = 10 Marks

1. The coupling field between electrical and mechanical systems of a DC machine is.
   a) Electric field
   b) Magnetic field
   c) Both electric and magnetic field
   d) None of the above
2. The DC motor is still used in industrial applications because it....
   a) Is cheap
   b) Is simple in construction
   c) Provides fine speed control
   d) None of the above
3. A separately excited DC generator is not used because
   a) It is costly
   b) Separate DC source is required for field circuit
   c) Voltage drops considerably with load
   d) None of the above
4. The main draw back of a DC shunt generator is that
   a) Terminal voltage drops considerably with load
   b) Shunt field circuit has high resistance
   c) Generated voltage is small
   d) It is expensive
5. When the speed of a DC motor increases, its armature current....
   a) Increases
   b) Decreases
   c) Remains constant
   d) None of the above
6. The speed of a DC motor is...
   a) Directly proportional to flux per pole
   b) Inversely proportional to flux per pole
   c) Inversely proportional to applied voltage
   d) None of the above
7. A transformer will work on
   a) AC only
   b) DC only
   c) AC as well as DC
   d) None of the above
8. The primary and secondary of a transformer are .....coupled.
   a) Electrically
   b) Magnetically
   c) Electrically and magnetically

Set B

d) None of the above

9. A single phase induction motor employs…
   a) Squirrel cage
   b) Wound
   c) Either squirrel cage and wound
   d) None of the above
10. Most of single phase induction motors are.. machines.
   a) 2-pole
   b) 6-pole
   c) 8-pole
   d) 4-pole

Section – B

04X04 = 16 Marks

1. What is back E.M.F or counter E.M.F?
2. How to make Single-Phase Induction Motor Self-Starting?
3. Explain briefly the important characteristics of a d.c. generator.
4. Explain the operation of Shaded-pole motor.

Section – C

04X06 = 24 Marks

1. What is DC Motor and explain the construction of DC motor.
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Section – A

10X10 = 10 Marks

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10. Most of single phase induction motors are.. machines.
   a) 2-pole
   b) 6-pole
   c) 8-pole
   d) **4-pole**

Section – B

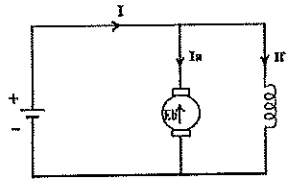
04X04 = 16 Marks

1. What is back E.M.F or counter E.M.F?

Solution: According to the fundamental law of nature, no energy conversion is possible until there is something to oppose the conversion. In case of generators, magnetic drag provides this opposition, but in the case of dc motors, there is back emf. Presence of the back emf makes a dc motor 'self-regulating'.

When the armature of a motor is rotating, the conductors are also cutting the magnetic flux lines and hence according to the Faraday's law of electromagnetic induction, an emf induces in the armature conductors.

The direction of this induced emf is such that it opposes the armature current (I_a). The circuit diagram below illustrates the direction of the back emf and armature current.



Significance of Back-EMF

Magnitude of back emf is directly proportional to speed of the motor. Consider the load on a dc motor is suddenly reduced. In this case, required torque will be small as compared to the current torque. Speed of the motor will start increasing due to the excess torque. Hence, being proportional to the speed, magnitude of the back emf will also increase. With increasing back emf armature current will start decreasing. Torque being proportional to the armature current, it will also decrease until it becomes sufficient for the load. Thus, speed of the motor will regulate.

On the other hand, if a dc motor is suddenly loaded, the load will cause decrease in the speed. Due to decrease in speed, back emf will also decrease which allows more armature current. Due to increase in armature current the torque will increase to fulfill the load requirement.

2. How to make Single-Phase Induction Motor Self-Starting?

Ans: The single-phase induction motor is not self- starting and it is undesirable to resort to mechanical spinning of the shaft or pulling a belt to start it. To make a single-phase induction motor self-starting, we should somehow produce a revolving stator magnetic field. This may be achieved by converting a single-phase supply into two-phase supply through the use of an additional winding. When the motor attains sufficient speed, the starting means (i.e., additional winding) may be removed depending upon the type of the motor.

3. Explain briefly the important characteristics of a d.c. generator.

Ans: The following are the three most important characteristics of a d.c. generator:

1. Open Circuit Characteristic (O.C.C.)

This curve shows the relation between the generated e.m.f. at no-load (E0) and the field current (If) at constant speed. It is also known as magnetic characteristic or no-load saturation curve. Its shape is practically the same for all generators whether separately or self-excited. The data for O.C.C. curve are obtained experimentally by operating the generator at no load and constant speed and recording the change in terminal voltage as the field current is varied.

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This curve shows the relation between the generated e.m.f. on load (E) and the armature current (Ia). The e.m.f. E is less than E0 due to the demagnetizing effect of armature reaction. Therefore, this curve will lie below the open circuit characteristic (O.C.C.). The internal characteristic is of interest chiefly to the designer. It cannot be obtained directly by experiment. It is because a voltmeter cannot read the e.m.f. generated on load due to the voltage drop in armature resistance. The internal characteristic can be obtained from external

characteristic if winding resistances are known because armature reaction effect is included in both characteristics.

3. External characteristic (V/IL)

This curve shows the relation between the terminal voltage (V) and load current (IL). The terminal voltage V will be less than E due to voltage drop in the armature circuit. Therefore, this curve will lie below the internal characteristic. This characteristic is very important in determining the suitability of a generator for a given purpose. It can be obtained by making simultaneous measurements of terminal voltage and load current (with voltmeter and ammeter) of a loaded generator.

4. Explain the operation of Shaded-pole motor.

Ans: **Shaded-Pole Motor**

The shaded-pole motor is very popular for ratings below 0.05 H.P. (~ 40 W) because of its extremely simple construction. It has salient poles on the stator excited by single-phase supply and a squirrel cage rotor as shown in Fig. (9.16).

A portion of each pole is surrounded by a short-circuited turn of copper strip called shading coil.

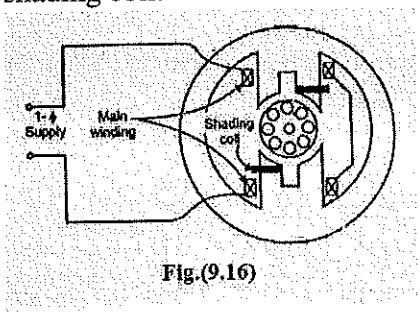


Fig.(9.16)

Operation

The operation of the motor can be understood by referring to Fig. (9.17) which shows one pole of the motor with a shading coil.

(i) During the portion OA of the alternating-current cycle [See Fig. (9.17)], the flux begins to increase and an e.m.f. is induced in the shading coil. The resulting current in the shading coil will be in such a direction (Lenz's law) so as to oppose the change in flux. Thus the flux in the shaded portion of the pole is weakened while that in the unshaded portion is strengthened as shown in Fig. (9.17 (ii)).

(ii) During the portion AB of the alternating-current cycle, the flux has reached almost maximum value and is not changing. Consequently, the flux distribution across the pole is uniform [See Fig. (9.17 (iii))] since no current is flowing in the shading coil. As the flux decreases (portion BC of the alternating current cycle), current is induced

in the shading coil so as to oppose the decrease in current. Thus the flux in the shaded portion of the pole is strengthened while that in the unshaded portion is weakened as shown in Fig. (9.17 (iv)).

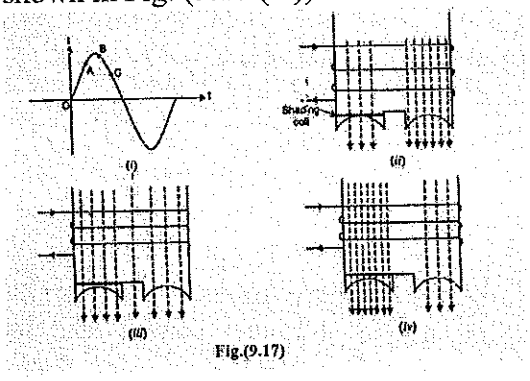


Fig.(9.17)

(iii) The effect of the shading coil is to cause the field flux to shift across the pole face from the unshaded to the shaded portion. This shifting flux is like a rotating weak field moving in the direction from unshaded portion to the shaded portion of the pole.
(iv) The rotor is of the squirrel-cage type and is under the influence of this moving field. Consequently, a small starting torque is developed. As soon as this torque starts to revolve the rotor, additional torque is produced by single-phase induction-motor action. The motor accelerates to a speed slightly below the synchronous speed and runs as a single-phase induction motor.

Section – C

04X06 = 24 Marks

1. What is DC Motor and explain the construction of DC motor.

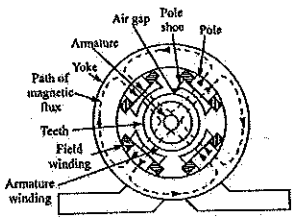
Ans: The **DC motor** is the motor which converts the direct current into the mechanical work. It works on the principle of Lorentz Law, which states that "the current carrying conductor placed in a magnetic and electric field experience a force". And that force is the Lorentz force.

Construction of DC Motor

Before understanding the working of DC motor first, we have to know about their construction. There are two main parts of the DC motor.

- Armature
- Stator

The rotating part is the armature and the Stator is their stationary part. The armature coil is connected to the DC supply.



The armature coil consists the commutators and brushes. The commutator converts the AC induces in the armature into DC and brushes transfer the current from rotating part of the motor to the stationary external load. The armature places between the north and south pole of the permanent or electromagnet.

PARTS OF THE STATOR:-

YOKE:

The yoke or outer frame provides coverage to a dc motor. It is made up of **cast steel** for large dc motors. And of **cast iron** for small dc motors. The yoke is used in DC machine because:

A) It provides mechanical support to poles.
B) Acts as a protective cover against mechanical damage.
C) And provides a passage for the magnetic flux produced by the poles of the machine.

POLE CORE AND POLE SHOE:

Both pole core and pole shoes are made of cast steel. But pole shoes are laminated as they are close to the armature.

If the load changes during the operation of the DC motor, the armature current changes. As a result the magnetic flux also changes. This flux links the pole shoe and causes **eddy current** to flow. And to minimize these eddy currents, pole shoes are laminated.

The main purpose of the pole shoe is to spread the flux and reduce the reluctance of the magnetic path. Whereas the pole core is excited with field winding and used to support them.

POLE WINDING OR FIELD COILS

The pole winding and field coils consist of copper wire placed in position around the pole core. When current passes through these coils, they electro-magnetize the pole which produces the magnetic flux. This flux passes through the rotor and produces a rotating torque as soon as the current starts flowing in the armature of the rotor.

PARTS OF THE ROTOR:-

ARMATURE CORE

The armature core is the rotating part of a DC/AC machine. It is made up of **silicon steel**. The cylindrical structure is laminated to reduce the eddy current loss. Its main purpose is to offer a low reluctance path to the magnetic flux. And to house the armature conductors.

ARMATURE WINDING

Armature winding is composed of coils embedded in armature core slots. These coils are lined next to each other with tough insulating material. The insulating material prevents the two adjacent coils from a short circuit.

Whereas the slot insulation is folded over the armature conductor and is secured firmly by wood or Fibre wedges. In simple words, it is an arrangement of current-carrying conductors that produce EMF in the machine due to relative motion between the windings and the main field.

COMMUTATOR

The commutator contains wedge-shaped hard drawn copper segments, forming a cylindrical structure. A thin sheet of **high-quality mica** insulates the segments from each other.

A commutator periodically changes the direction of the current between the rotor and external circuit. Hence, it acts as a switch causing a unidirectional torque in the dc motor.

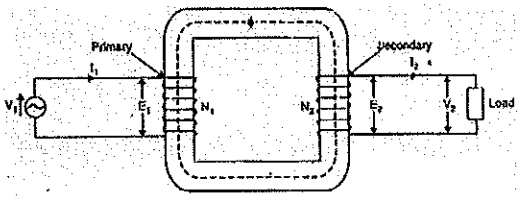
BRUSHES

Brushes are usually made of rectangular carbon blocks housed in brush holders. The function of brushes in DC motors is to supply the current to the commutator from an external dc source.

Whereas the function of the brushes in a **DC generator** is to collect the current from the commutator and supply it to the external load circuit.

2. What is transformer and explain the working of transformer.

Ans: A transformer is a static piece of equipment used either for raising or lowering the voltage of an a.c. supply with a corresponding decrease or increase in current. It essentially consists of two windings, the primary and secondary, wound on a common laminated magnetic core as shown in Fig. The winding connected to the a.c. source is called primary winding (or primary) and the one connected to load is called secondary winding (or secondary). The alternating voltage V1 whose magnitude is to be changed is applied to the primary. Depending upon the number of turns of the primary (N1) and secondary (N2), an alternating e.m.f. E2 is induced in the secondary. This induced e.m.f. E2 in the secondary causes a secondary current I2. Consequently, terminal voltage V2 will appear across the load. If V2 > V1, it is called a step up-transformer. On the other hand, if V2 < V1, it is called a step-down transformer.



Working

When an alternating voltage V1 is applied to the primary, an alternating flux f is set up in the core. This alternating flux links both the windings and induces e.m.f.s E1 and E2 in them according to Faraday's laws of electromagnetic induction. The e.m.f. E1 is termed as primary e.m.f. and e.m.f. E2 is termed as secondary e.m.f.

Clearly, $E_1 = -N_1 \frac{d\phi}{dt}$

and $E_2 = -N_2 \frac{d\phi}{dt}$

$\therefore \frac{E_2}{E_1} = \frac{N_2}{N_1}$

Note that magnitudes of E2 and E1 depend upon the number of turns on the secondary and primary respectively. If N2 > N1, then E2 > E1 (or V2 > V1) and we get a step-up transformer. On the other hand, if N2 < N1, then E2 < E1 (or V2 < V1) and we get a step-down transformer. If load is connected across the secondary winding, the secondary e.m.f. E2 will cause a current I2 to flow through the load. Thus, a transformer enables us to transfer a.c. power from one circuit to another with a change in voltage level.

The following points may be noted carefully:

(i) The transformer action is based on the laws of electromagnetic induction.

(ii) There is no electrical connection between the primary and secondary.

The a.c. power is transferred from primary to secondary through magnetic flux.

(iii) There is no change in frequency i.e., output power has the same frequency as the input power.

(iv) The losses that occur in a transformer are:

(a) core losses—eddy current and hysteresis losses

(b) copper losses—in the resistance of the windings

In practice, these losses are very small so that output power is nearly equal to the input primary power. In other words, a transformer has very high efficiency.

3. Explain the principle and construction of DC generator.

Ans: Generator Principle

An electric generator is a machine that converts mechanical energy into electrical energy. An electric generator is based on the principle that whenever flux is cut by a conductor, an e.m.f. is induced which will cause a current to flow if the conductor circuit is closed. The direction of induced e.m.f. (and hence current) is given by Fleming's right hand rule. Therefore, the essential components of a generator are:

(a) a magnetic field

(b) conductor or a group of conductors

(c) motion of conductor w.r.t. magnetic field.

Construction of d.c. Generator

The d.c. generators and d.c. motors have the same general construction. In fact, when the machine is being assembled, the workmen usually do not know whether it is a d.c. generator or motor. Any d.c. generator can be run as a d.c. motor and vice-versa. All d.c. machines have five principal components viz., (i) field system (ii) armature core (iii) armature winding (iv) commutator (v) brushes [See Fig. 1.7].

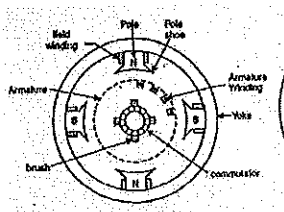


Fig. (1.7)

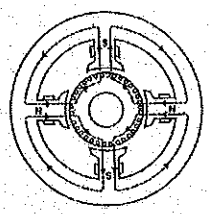


Fig. (1.8)

(i) Field system

The function of the field system is to produce uniform magnetic field within which the armature rotates. It consists of a number of salient poles (of course, even number) bolted to the inside of circular frame (generally called yoke). The yoke is usually made of solid cast steel whereas the pole pieces are composed of stacked laminations. Field coils are mounted on the poles and carry the d.c. exciting current. The field coils are connected in such a way that adjacent poles have opposite polarity.

The m.m.f. developed by the field coils produces a magnetic flux that passes through the pole pieces, the air gap, the armature and the frame (See Fig. 1.8). Practical d.c. machines have air gaps ranging from 0.5 mm to 1.5 mm. Since armature and field systems are composed of materials that have high permeability, most of the m.m.f. of field coils is required to set up flux in the air gap. By reducing the length of air gap, we can reduce the size of field coils (i.e. number of turns).

(ii) Armature core

The armature core is keyed to the machine shaft and rotates between the field poles. It consists of slotted soft-iron laminations (about 0.4 to 0.6 mm thick) that are stacked to form a cylindrical core as shown in Fig (1.9). The laminations (See Fig. 1.10) are individually coated with a thin insulating film so that they do not come in electrical contact with each other. The purpose of laminating the core is to reduce the eddy current loss. The laminations are slotted to accommodate and provide mechanical security to the armature winding and to give shorter air gap for the flux to cross between the pole face and the armature "teeth".

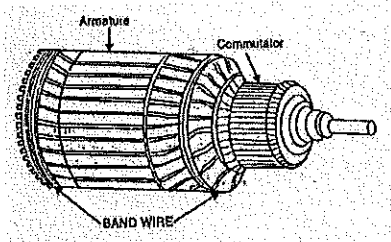


Fig. (1.9)

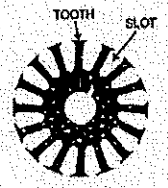


Fig. (1.10)

(iii) Armature winding

The slots of the armature core hold insulated conductors that are connected in a suitable manner. This is known as armature winding. This is the winding in which "working" e.m.f. is induced. The armature conductors are connected in series-parallel; the conductors being connected in series so as to increase the voltage and in parallel paths so as to increase the current. The armature winding of a d.c. machine is a closed-circuit winding; the conductors being connected in a symmetrical manner forming a closed loop or series of closed loops.

(iv) Commutator

A commutator is a mechanical rectifier which converts the alternating voltage generated in the armature winding into direct voltage across the brushes. The commutator is made of copper segments insulated from each other by mica sheets and mounted on the shaft of the machine (See Fig 1.11). The armature conductors are soldered to the commutator segments in a suitable manner to give rise to the armature winding. Depending upon the manner in which the armature conductors are connected to the commutator segments, there are two types of armature winding in a d.c.

machine viz., (a) lap winding (b) wave winding. Great care is taken in building the commutator because any eccentricity will cause the brushes to bounce, producing unacceptable sparking. The sparks may bum the brushes and overheat and carbonise the commutator.

(v) Brushes

The purpose of brushes is to ensure electrical connections between the rotating commutator and stationary external load circuit. The brushes are made of carbon and rest on the commutator. The brush pressure is adjusted by means of adjustable springs (See Fig. 1.12). If the brush pressure is very large, the friction produces heating of the commutator and the brushes. On the other hand, if it is too weak, the imperfect contact with the commutator may produce sparking.

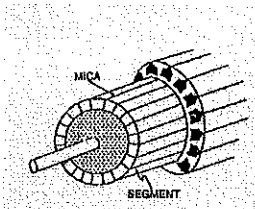


Fig. (1.11)

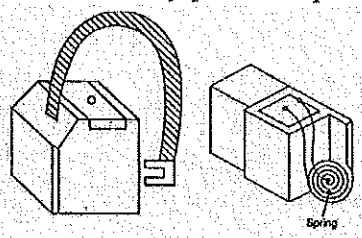


Fig. (1.12)

Multipole machines have as many brushes as they have poles. For example, a 4-pole machine has 4 brushes. As we go round the commutator, the successive brushes have positive and negative polarities. Brushes having the same polarity are connected together so that we have two terminals viz., the +ve terminal and the -ve terminal.

4. Drive the EMF equation of DC generator.

Ans: E.M.F. Equation of a D.C. Generator

We shall now derive an expression for the e.m.f. generated in a d.c. generator.

Let f = flux/pole in Wb

Z = total number of armature conductors

P = number of poles

A = number of parallel paths = 2 ... for wave winding

= P ... for lap winding

N = speed of armature in r.p.m.

Eg = e.m.f. of the generator = e.m.f./parallel path

Flux cut by one conductor in one revolution of the armature,

$$d\phi = P\phi \text{ webers}$$

Time taken to complete one revolution,

$$dt = 60/N \text{ second}$$

$$\text{e.m.f generated/conductor} = \frac{d\phi}{dt} = \frac{P\phi}{60/N} = \frac{P\phi N}{60} \text{ volts}$$

e.m.f. of generator,

E_g = e.m.f. per parallel path

= (e.m.f/conductor) × No. of conductors in series per parallel path

$$= \frac{P\phi N}{60} \times \frac{Z}{A}$$

$$\therefore \quad E_g = \frac{P\phi ZN}{60A}$$

where A = 2 for-wave winding

= P for lap winding

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Registration No.: .....

School of Electrical Skills
Session: 2021-22 (Summer Semester)
B. Voc. Program, 3rd Semester,
End-Sem. Examination

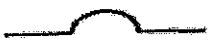
Course Code: ELE1307 **Time: 2 Hours**
Course Name: Electrical Circuit and Drawing **Max. Marks: 50**

Instruction: Answer all questions from each and every section. Section A, each question carries one mark, section B, each question carries four marks and in section C, each question carries six marks. Scientific calculator is allowed.

Section – A

10X01 = 10 Marks

1. KCL works on the principle of:
   (a) Charge conservation (c) Energy conservation
   (b) Power conservation (d) None of these
2. Unit of Inductor is:
   (a) Kwh (b) Henry (c) Farad (d) All of these
3. Delivered power + Absorbed power of an element is:
   (a) Not equal to zero (c) Absorbed power
   (b) Zero (d) None of these
4. Voltage will be same at every point in:
   (a) Parallel Circuit (c) Series Circuit
   (b) Mixed Circuit (d) None of these
5. Full form of SLD
   (a) Single Line Diaphragm (c) Single Line Diagram
   (b) Second Line Diagram (d) All of these
6. Current division rule can be applied in:
   (a) Series Circuit (c) Parallel Circuit
   (b) Mixed Circuit (d) Both b and c
7. This is the symbol of:

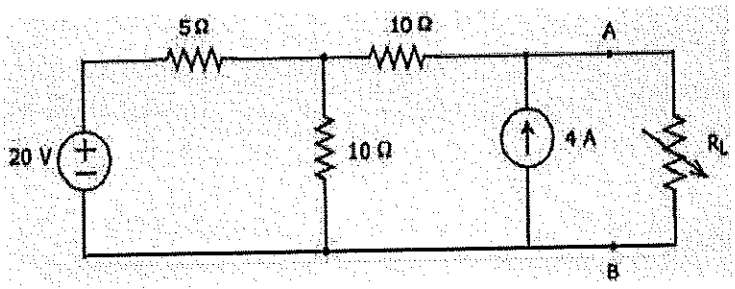


   (a) Oil Circuit Breaker (c) Air circuit breaker
   (b) SF_6 Circuit Breaker (d) None of these
8. Unit of Energy is:
   (a) Kwh (b) Joules (c) Watt-Second (d) All of these
9. Full form of PVC:
   (a) Polyvinyl Chloride c) Polyvinyl Chloride
   (b) Photovoltaic Control d) None of these
10. ANSI number 59 represents:
    a) Overvoltage Relay c) Undervoltage Relay
    b) Over Frequency relay d) None of these

Section – B

04X04 = 16 Marks

1. What is the need of SLD?
2. Write short note on Specification of wires required for the wiring purpose.
3. State Ohm's law, KVL and KCL.
4. Calculate the value of RL resistance for Maximum Power Transfer.



Set A
Rishi Jain

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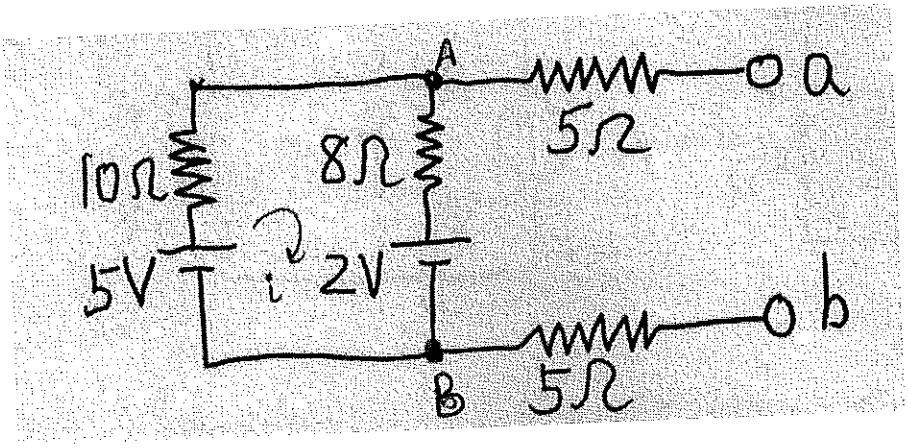
Section – C

04X06 = 24 Marks

1. Draw the SLD of a 33 KV/11 KV Substation also write the basic details of the different electrical equipment used.
2. Explain the factors affecting the choice of wiring.
3. Draw the planning flowchart of Single phase and three phase supply building wiring installations.
4. Calculate Vth and Rth across a-b terminals.



Answers Key

Course Code: ELE1307, Course Name: Electrical Circuit and Drawing
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, III Semester, End-Sem. Examination

Section-A

1. A
2. B
3. B
4. A
5. C
6. D
7. C
8. D
9. A
10. A

Section-B

1. **Need of SLD:**
   - The single line diagram has its largest applications in power flow studies.
   - The single line diagram is also useful for understanding the design of power grid.
   - For any electrical system before installation we need to prepare its single line diagram for better understanding of process.
   - A properly drawn SLD shows a correct power distribution path from the incoming power source to each downstream load including the ratings and sizes of each piece of electrical equipment, their circuit conductors, and their protective devices.
   - Making the electrical system easily understandable for any technical person inside/outside of the factory.
2. **Specification of Wires to be considered for wiring:**
   - The conductor material, insulation, size and the number of cores, specifies the electrical wires.
   - The conductors are usually of either copper or aluminium.
   - Various insulating materials like PVC (Polyvinyl Chloride), TRS and VIR are used.
   - The wire may be of single strand or multi strand.
   - Wires with combination of different diameters and the number of cores or strands are available.
   - The selection of the wire is made depending on the requirement considering factors like current and voltage ratings, cost and application.
   - The current carrying capacity depends on the total area of the wires.
3. **Ohm's Law:**

Wherever a voltage source is applied across a conductor, current will start flowing through it because of potential difference from higher potential to lower potential.

Ohm's Law states that the current flowing through a conductor is directly proportional to the potential difference (voltage) applied across its ends, provided that temperature and other physical conditions remain unchanged.

$$V \alpha I$$

$$V = I*R$$

Where R= proportionality constant, known as Resistance

- Ohm's law is not applicable for unilateral electrical elements like diodes and transistors as they allow the current to flow through in one direction only.
- For non- linear elements also, ohm's law is not applicable.

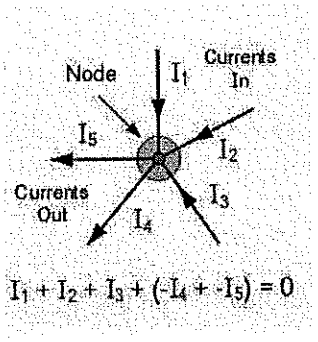
Kirchhoff's Law Statement

Answers Key

Course Code: ELE1307, Course Name: Electrical Circuit and Drawing
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, III Semester, End-Sem. Examination

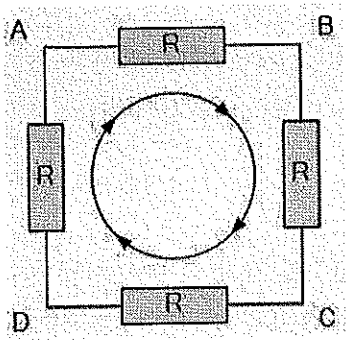
Kirchhoff's laws are one of the fundamental laws that find applications in electrical engineering for formulating the circuits. There are two laws that make up the Kirchhoff's law and they are:

Kirchhoff's Current Law (KCL): KCL is also known as Kirchhoff's first law or junction rule. The principle of this law is to conserve the electric charge. The law states that the amount *of current flowing into a node/junction is equal to the sum of currents flowing out of it.* For performing the nodal analysis in Ohm's law, KCL is used.



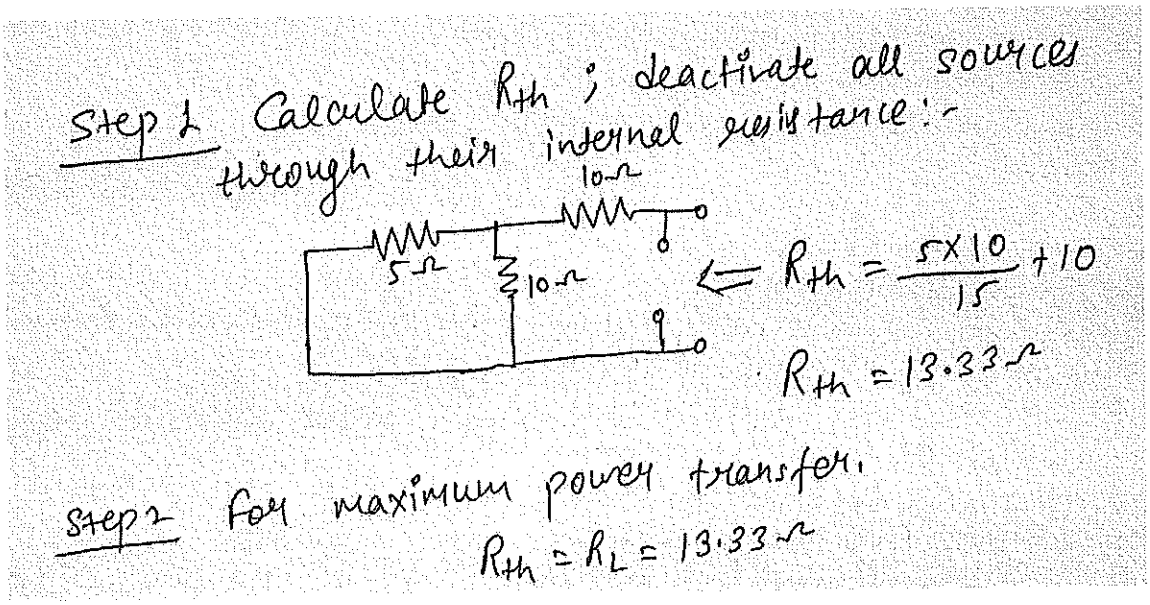
$I_1 + I_2 + I_3 + (-I_4 + -I_5) = 0$

Kirchhoff's Voltage Law (KVL): KVL is also known as Kirchhoff's second law or loop law. The principle of this law is to conserve energy. The law states that the *sum of voltages in a closed-loop is zero.* The total amount of energy gained is equal to the energy lost per unit charge.



$V_{AB} + V_{BC} + V_{CD} + V_{DA} = 0$

4.

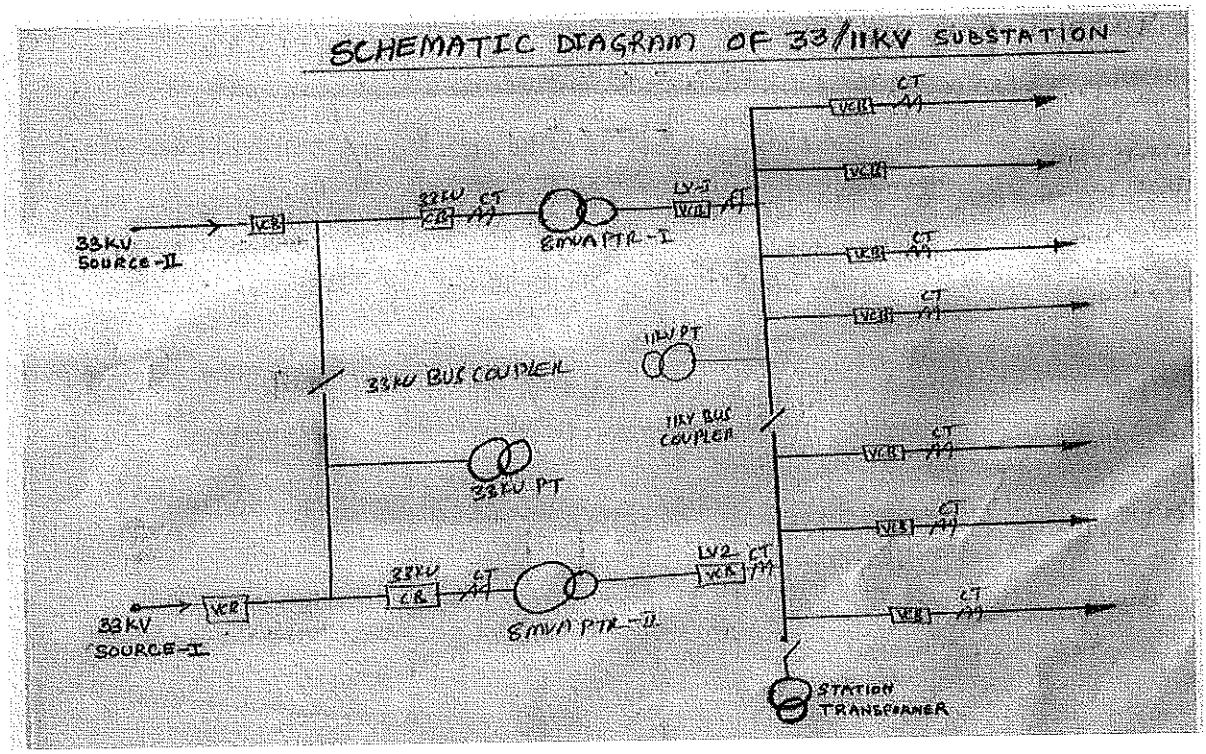


Answers Key

Course Code: ELE1307, Course Name: Electrical Circuit and Drawing
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, III Semester, End-Sem. Examination

Section-C

1.



A typical package of single line diagram shall include: -

- Incoming lines showing voltage and size
- Incoming main fuses, cutouts, switches, and main/tie breakers
- Power transformers (rating, winding connection)
- Feeder breakers and fused switches rating.
- Relays (function, use and type)
- All main cable and wire runs with their associated isolating switches
- All substations, including integral relays and main panels with total load of each feeder and each substation
- A load schedule for each distribution panels and switch board.
- Rating and numbers of bus bar.
- All outgoing cables with cable size with rating and type of their associated isolating switches.
- All connected load with their individual load capacity.

Answers Key

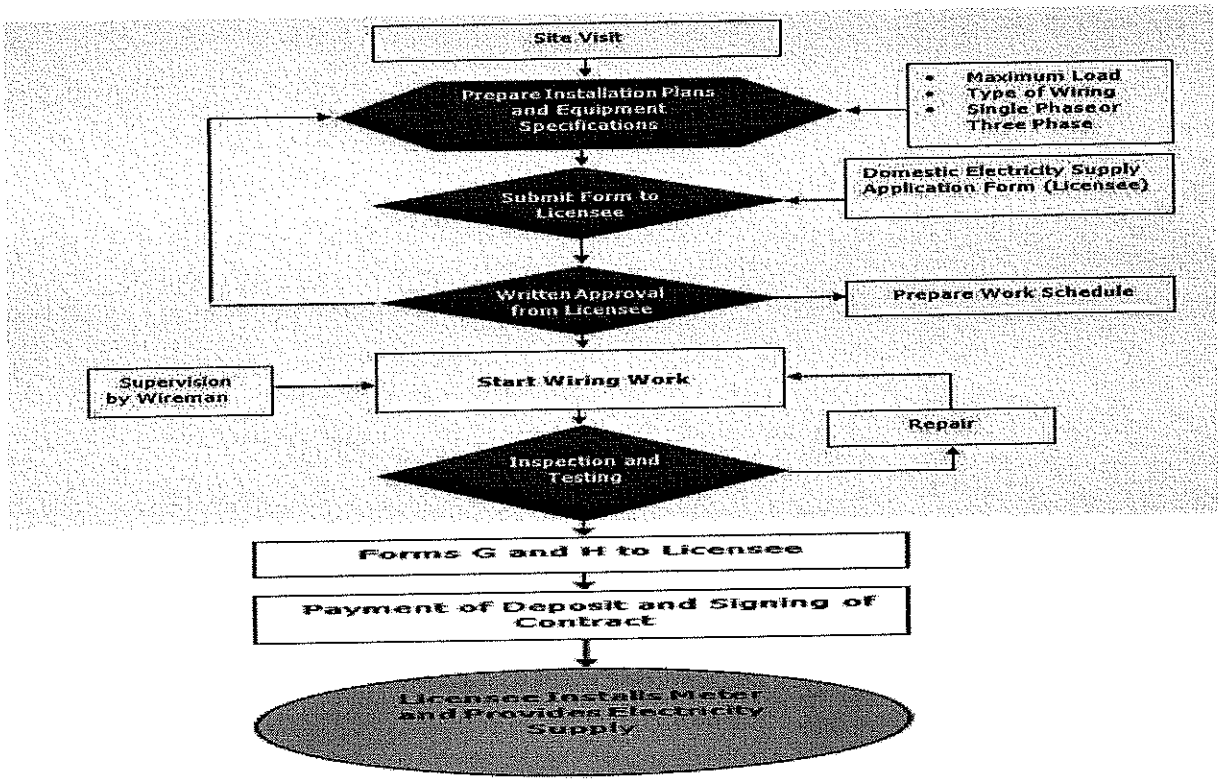
Course Code: ELE1307, Course Name: Electrical Circuit and Drawing
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, III Semester, End-Sem. Examination

2.

Factors Affecting the Choice of Wiring

- Durability : Type of wiring selected should conform to standard specifications, so that it is durable i.e. without being affected by the weather conditions, fumes etc.
- Safety : The wiring must provide safety against leakage, shock and fire hazards for the operating personnel.
- Appearance : Electrical wiring should give an aesthetic appeal to the interiors.
- Cost: It should not be prohibitively expensive.
- Accessibility : The switches and plug points provided should be easily accessible. There must be provision for further extension of the wiring system, if necessary.
- Maintenance Cost : The maintenance cost should be a minimum.
- Mechanical safety : The wiring must be protected against any mechanical damage.

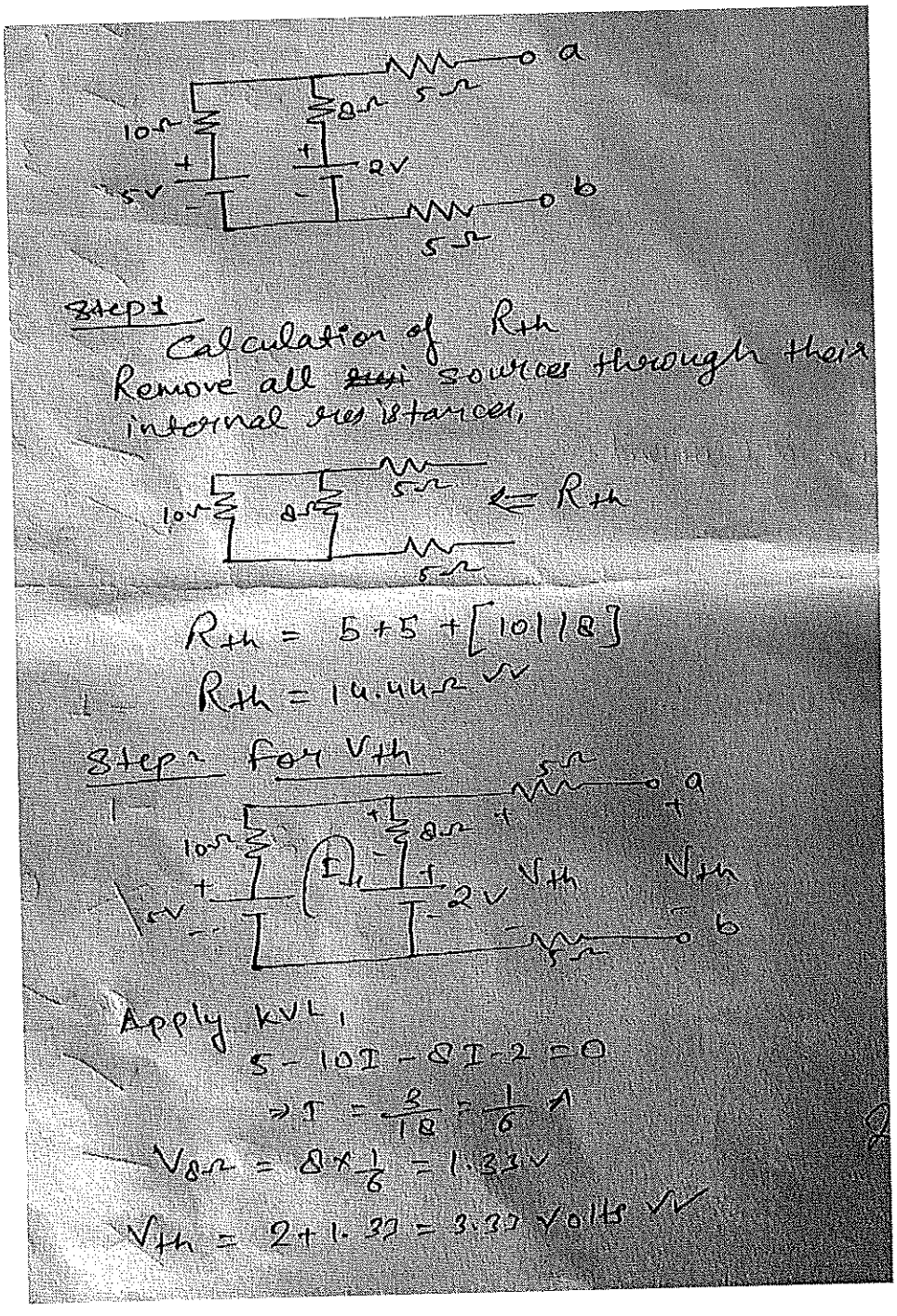
3.



Answers Key

Course Code: ELE1307, Course Name: Electrical Circuit and Drawing
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, III Semester, End-Sem. Examination

4.



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Registration No.: .....

School of Electrical Skills
Session: 2021-22 (Summer Semester)
B. Voc. Program, 3rd Semester,
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Course Code: ELE1307 **Time: 2 Hours**
Course Name: Electrical Circuit and Drawing **Max. Marks: 50**

Instruction: Answer all questions from each and every section. Section A, each question carries one mark, section B, each question carries four marks and in section C each question carries six marks. Scientific calculator is allowed.

Section – A

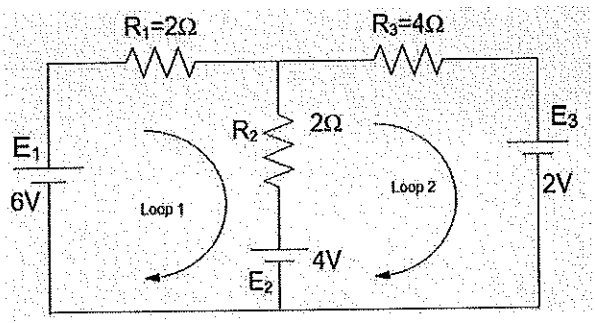
10X01 = 10 Marks

1. KVL works on the principle of:
   (a) Charge conservation (c) Energy conservation
   (b) Power conservation (d) None of these
2. Unit of Capacitor is:
   (a) Kwh (b) Henry (c) Farad (d) All of these
3. Delivered power + Absorbed power of an element is:
   (a) Not equal to zero (c) Absorbed power
   (b) Zero (d) None of these
4. Current will be same in:
   (a) Parallel Circuit (c) Series Circuit
   (b) Mixed Circuit (d) None of these
5. Full form of CAD
   (a) Computer and Diagram (c) Computer Aided Design
   (b) Cum Aided Diagram (d) All of these
6. Current division rule can be applied in:
   (a) Series Circuit (c) Parallel Circuit
   (b) Mixed Circuit (d) Both b and c
7. Active elements have:
   (a) Positive slope coefficient (c) Negative slope coefficient
   (b) Positive slope in 1st quadrant only (d) None of these
8. Unit of Power is:
   (a) Kwh (b) Joules (c) Watt-Second (d) None of these
9. Full form of PVC:
   (a) Polyvinyl Chloride (c) Polyvinyl Chloride
   (b) Photovoltaic Control (d) None of these
10. ANSI number 74 represents:
    (a) Alarm (c) Under voltage Relay
    (b) Over Frequency relay (d) None of these

Section – B

04X04 = 16 Marks

1. What must a typical SLD should include?
2. Write points to be considered while selecting any system of wiring.
3. State Ohm's law, KVL and KCL.
4. Calculate the value of current in both loops.



set B

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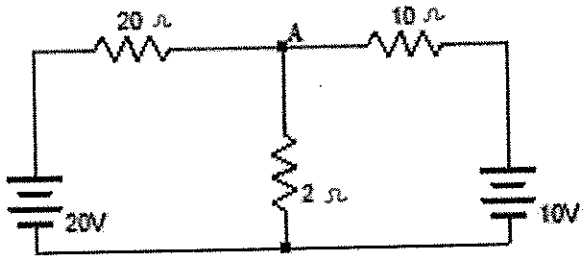
Section – C

04X06 = 24 Marks

1. Draw the SLD of a 33 KV/11 KV Substation.
2. Explain any of the two:
   (a) Block diagram (b) Line diagram (c) Circuit diagram (d) Wiring diagram.
3. Draw the planning flowchart of Single phase and three phase supply building wiring installations.
4. Find the voltage across 2-ohm resistor using Superposition Theorem.



Answers Key

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School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, III Semester, End-Sem. Examination

Section-A

1. C
2. C
3. B
4. C
5. C
6. B
7. C
8. D
9. A
10. A

Section-B

1. **A typical package of single line diagram shall include: -**

- Incoming lines showing voltage and size
- Incoming main fuses, cutouts, switches, and main/tie breakers
- Power transformers (rating, winding connection)
- Feeder breakers and fused switches rating.
- Relays (function, use and type)
- All main cable and wire runs with their associated isolating switches
- All substations, including integral relays and main panels with total load of each feeder and each substation
- A load schedule for each distribution panels and switch board.
- Rating and numbers of bus bar.
- All outgoing cables with cable size with rating and type of their associated isolating switches.
- All connected load with their individual load capacity.

2.

Points to be Considered While Selecting Any System of Wiring

- Life of installation
- Future extension or alterations
- Construction of building
- Fire hazards or other special conditions
- Corrosive fumes (Gases which are responsible for corrosion)
- Dampness (Unwanted Moisture)
- Type of wire and material used
- Nature of load (lighting of power)
- Safety of the system
- Cost of wiring system

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3. Ohm's Law:

Wherever a voltage source is applied across a conductor, current will start flowing through it because of potential difference from higher potential to lower potential.

Ohm's Law states that the current flowing through a conductor is directly proportional to the potential difference (voltage) applied across its ends, provided that temperature and other physical conditions remain unchanged.

$$V \alpha I$$

$$V = I*R$$

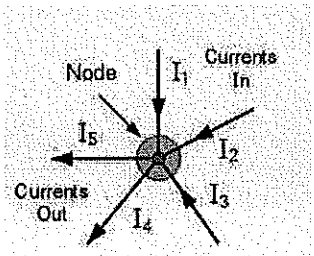
Where R= proportionality constant, known as Resistance

- Ohm's law is not applicable for unilateral electrical elements like diodes and transistors as they allow the current to flow through in one direction only.
- For non- linear elements also, ohm's law is not applicable.

Kirchhoff's Law Statement

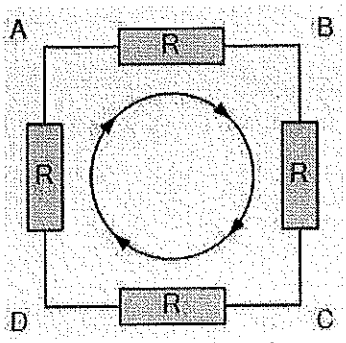
Kirchhoff's laws are one of the fundamental laws that find applications in electrical engineering for formulating the circuits. There are two laws that make up the Kirchhoff's law and they are:

Kirchhoff's Current Law (KCL): KCL is also known as Kirchhoff's first law or junction rule. The principle of this law is to conserve the electric charge. The law states that the amount *of current flowing into a node/junction is equal to the sum of currents flowing out of it.* For performing the nodal analysis in Ohm's law, KCL is used.



$$I_1 + I_2 + I_3 + (-I_4 + -I_5) = 0$$

Kirchhoff's Voltage Law (KVL): KVL is also known as Kirchhoff's second law or loop law. The principle of this law is to conserve energy. The law states that the *sum of voltages in a closed-loop is zero.* The total amount of energy gained is equal to the energy lost per unit charge.



$$V_{AB} + V_{BC} + V_{CD} + V_{DA} = 0$$

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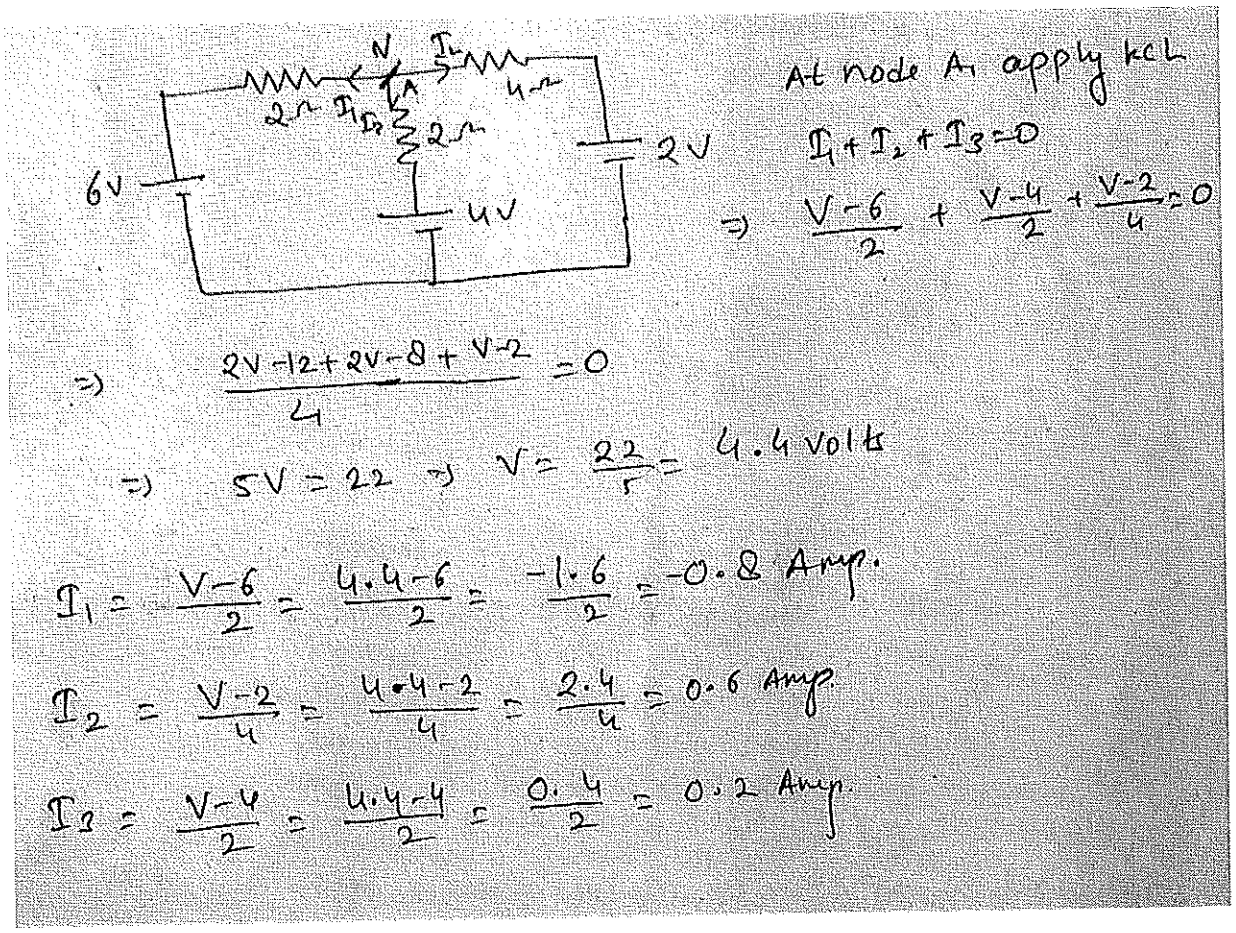


At node A, apply KCL

$I_1 + I_2 + I_3 = 0$

$\Rightarrow \frac{V-6}{2} + \frac{V-4}{2} + \frac{V-2}{4} = 0$

$\Rightarrow \frac{2V-12+2V-8+V-2}{4} = 0$

$\Rightarrow 5V = 22 \Rightarrow V = \frac{22}{5} = 4.4$ volts

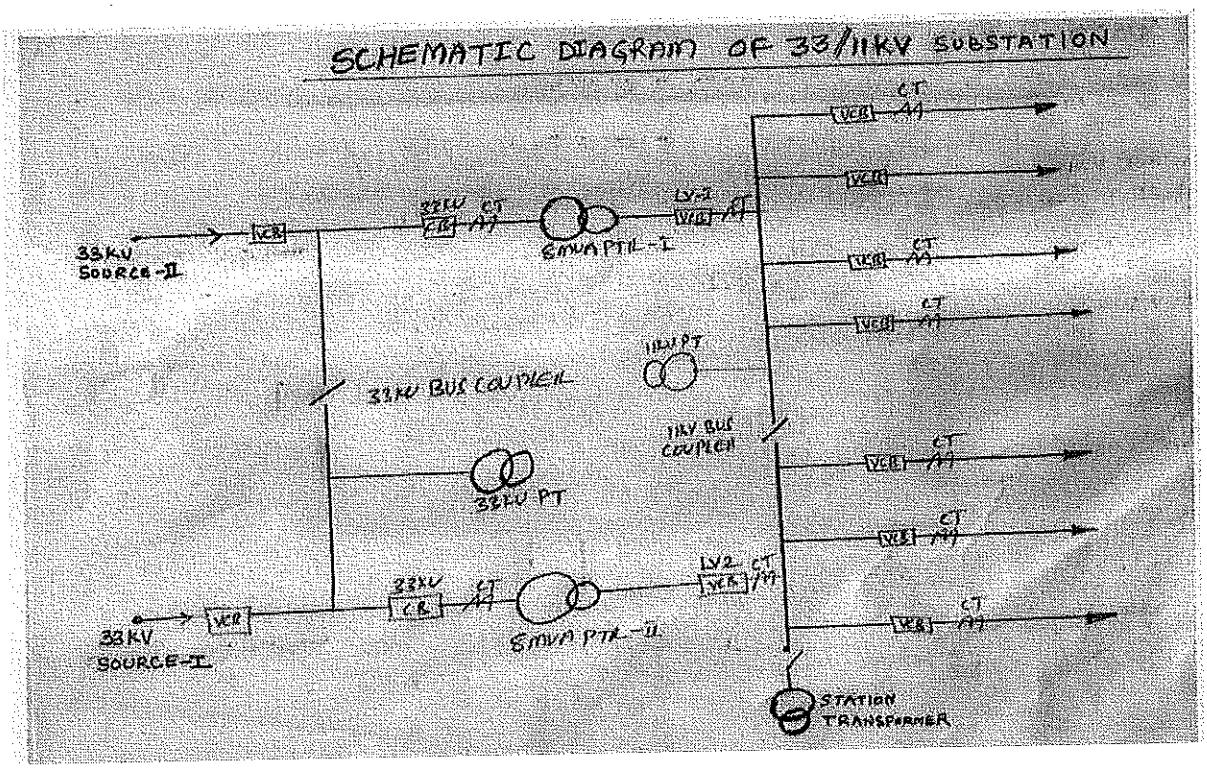
$I_1 = \frac{V-6}{2} = \frac{4.4-6}{2} = \frac{-1.6}{2} = -0.8$ Amp.

$I_2 = \frac{V-2}{4} = \frac{4.4-2}{4} = \frac{2.4}{4} = 0.6$ Amp

$I_3 = \frac{V-4}{2} = \frac{4.4-4}{2} = \frac{0.4}{2} = 0.2$ Amp.

Section-C

1.



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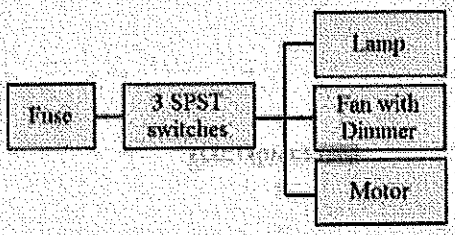
2. Block Diagram:

- It is a functional drawing which shows and describes the main operating principles of the equipment's or devices.
- It consists of :-

- principle functions (represented by blocks)
- line connections (shows relationship between them).

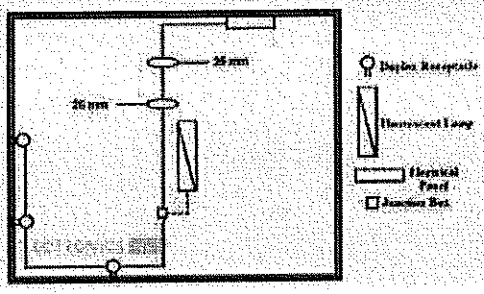
The diagram is usually drawn before implementing a circuit diagram.

- Not give any detailed information.
- Leaves the information about smaller cmponents.



Circuit Diagram

- Electrical circuit is graphically represented in a simplified manner.
- It gives the position information of various elements (in cm or m or mm).
- Doesn't give any layout of the parts and their detail wiring information of the components.
- One can do wiring by following the information given in this diagram.
- These diagram illustrate the working of an electric circuit.



Wiring Diagram

- Wiring diagram is a representation of the circuit, shows the wiring between parts or elements.
- Gives detailed information about wiring .
- It includes:-

-relative position
-arrangement of devices
-terminals on the devices

It shows power supplies and earth connections .

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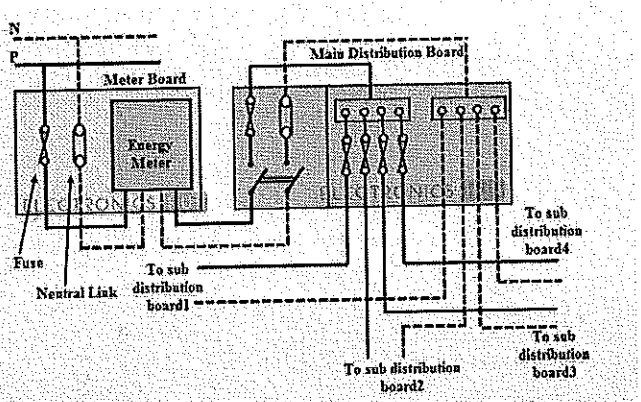
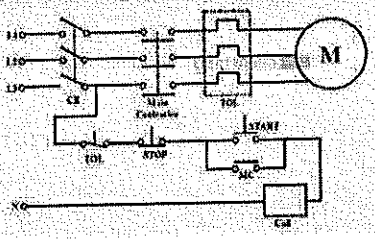


Line Diagram

- Is a simplified notation of an electrical system.
- Called as one-line diagram or single line diagram .
- Similar to the block diagram.
- It consists of symbols to represent the components.
- Lines to represent the wires or conductors which connects the components together.
- The line diagram is derived from the block diagram.



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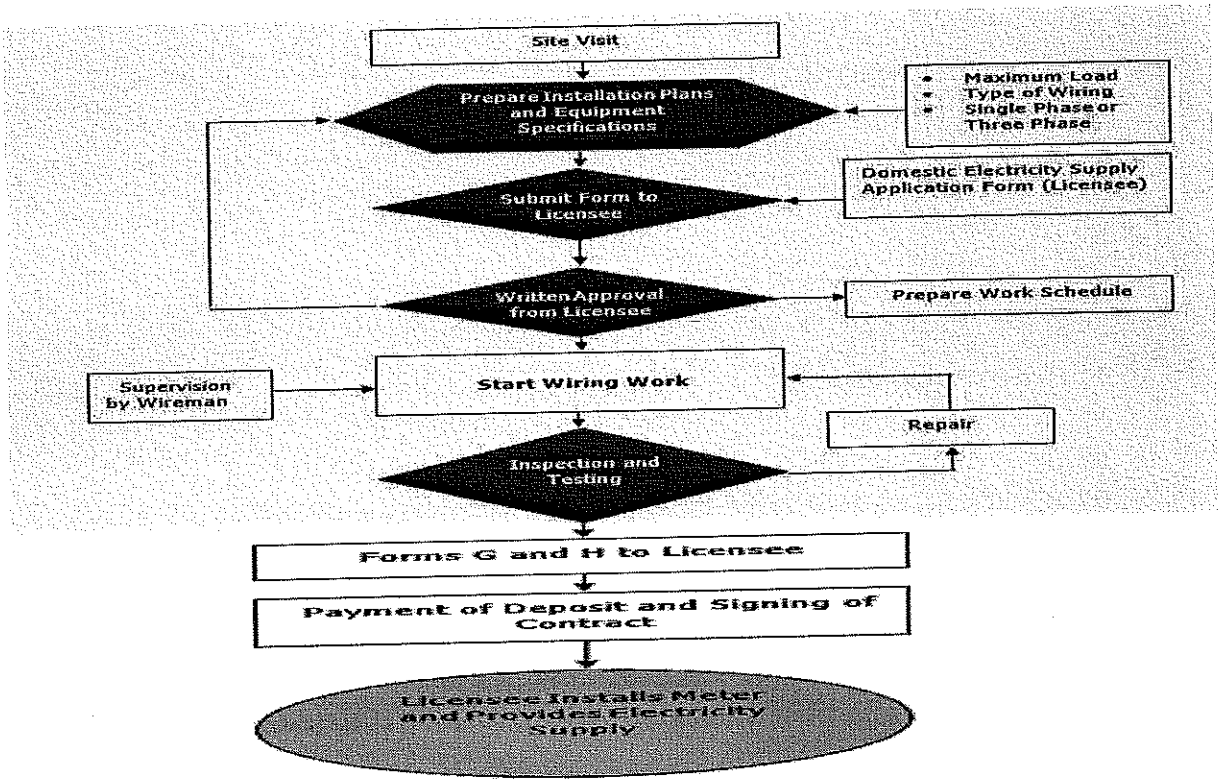

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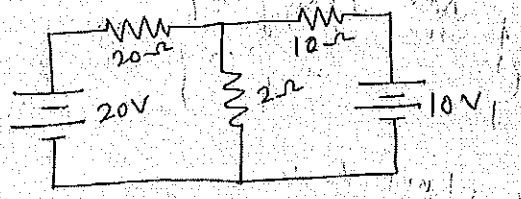
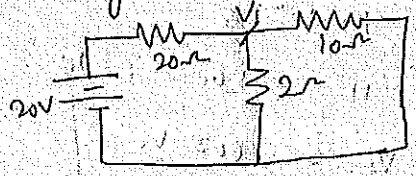


Step 1 Consider 20V source active & deactivate 10V source using internal resistance.



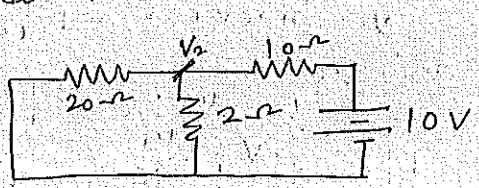
From Nodal analysis,

$$\frac{V_1 - 20}{20} + \frac{V_1}{2} + \frac{V_1}{10} = 0$$

$$\Rightarrow \frac{13V_1 - 20}{20} = 0$$

$$\Rightarrow V_1 = \frac{20}{13} = 1.53 \text{ volts} \quad -(1)$$

Step 2 Consider 10 volt source & deactive 20 volt source



$$\Rightarrow \frac{V_2 - 10}{10} + \frac{V_2}{2} + \frac{V_2}{20} = 0$$

$$\Rightarrow \frac{2V_2 - 20 + 10V_2 + V_2}{20} = 0$$

$$\Rightarrow 13V_2 = 20$$

$$V_2 = 1.52 \text{ volts} \quad -(2)$$

Step 3 Voltage across 2Ω resistor

$$= V_1 + V_2 = 1.53 + 1.53$$

$$= 3.06 \text{ volts}$$