Industrial Electrical/Electronics Control Technology

Level-II

Based on March 2022, Curriculum Version 1

Module Title: Operating application software packages

Module code: EIS IEC2 M04 0322

Nominal duration: 80 Hour

Prepared by: Ministry of Labor and Skill

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Addis Ababa, Ethiopia

Table of Content

Acknowledgment

Ministry of Labor and Skills wish to extend thanks and appreciation to the many representatives of TVT instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

Acronym

BOM- Bill of Material

CAD- Computer Aided Design

CPU- Central Processing Units

DLL- Dynamic Link Library

I/O- Input/Output

IDE- Integrated Development Environment

IRPA- International Radiation Protection Association

IT- Information Technology

LCD- Liquid Crystal Display

OS- Operating System

PCB- Printed Circuit Board

RAM- Random Access Memory

SLD- Single Line Diagram

Introduction to the Module

In the field of Industrial Electrical/Electronic Technology; operating application software package's is an important skill to acquire in today's emerging technologies, it will help trainees to get familiar with in designing, constructing, troubleshooting, simulating and automating different electrical and electronics circuits/system.

This module is designed to meet the industry requirement under the Industrial Electrical/Electronic Control Technology occupational standard, particularly for the unit of competency: Operate application software packages s

This module covers the units:

- Planning and preparing electrical drawings
- Selecting and using electrical drawing software packages
- Finalizing works on electrical drawing

Learning Objective of the Module

- Plan and prepare
- Select and use electrical drawing software packages,
- Perform finalize works

Module Instruction

For the effective use of this module's trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the "LAP test" giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

Unit one: Planning and preparing electrical drawings

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Safe work practice and ergonomic.
- Anti-glare mechanism for high radiation screens
- Electrical software packages

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Apply safe work practice and ergonomic.
- Use anti-glare mechanism for high radiation screens
- Obtain electrical software packages

1.1. Safe work practice and ergonomic

1.1.1 Ergonomics and Safety

Ergonomics, as defined by the International Ergonomic Association, is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance. When the principles of ergonomics are applied in the context of workplace safety, the concept of ergonomic safety is born. Ergonomics safety ensures that the products, methods, and environment that worker uses are appropriate to fit the worker's job requirements and personal capabilities.

Why is Ergonomics Important in Workplace Safety?

Ergonomic disorders are the fastest-growing category of work-related illness. Many of these are caused by ergonomic work-related injuries like carpal tunnel syndrome alone, tendinitis, rotator cuff injuries, muscle strains, and low back injuries due to risk factors like high task repetition, forceful exertions, and repetitive awkward postures.

What are the Benefits of Ergonomics?

The implementation of ergonomics safety as part of the workplace safety program helps ensure that employees' capabilities and physical limitations are matched with the right tools and working spaces to ensure comfortable and safe working conditions for them. The benefits of an ergonomics safety program can not only make an impact on the lives of employees, but it can also make a difference in the overall efficiency of the entire organization. Here are some of the most notable benefits of ergonomic safety in the workplace:

- *Helps prevent other incidents and injuries*

Workers who experience discomfort on the job may find shortcuts or workarounds that could result in incidents and injuries such as slips, falls, and lacerations.

- *Improves overall productivity*

Healthy employees are your most valuable asset; creating and fostering the safety & health culture at your company will lead to improved productivity for your organization.

- *Helps foster employee engagement and satisfaction*

Employees notice when the company is putting forth their best efforts to ensure their health and safety. It shows your company's commitment to safety and health as a core value.

How to Spot and Correct Ergonomic Hazards

Here are some general ergonomic safety tips to help prevent the most prevalent ergonomic hazards:

Workstation improvements

- ✓ Redesign workstations to eliminate awkward postures.
- ✓ Provide adjustable equipment that can be used by workers to allow neutral postures.
- ✓ Maintain good body posture.

Staff scheduling and training

- ✓ Rotate workers among different tasks to avoid repetitive motions.
- ✓ Improve the work schedule to minimize excessive overtime that causes fatigue.
- ✓ Increase staff to reduce individual workloads.
- ✓ Provide sufficient employee breaks.
- ✓ Adequate recovery time can reduce fatigue.
- ✓ Provide workers with training on ergonomics policies and procedure

General housekeeping

- ✓ Follow good housekeeping practices.
- ✓ Keep floors free of obstruction.
- ✓ Use tools in good condition that fits the hand.
- ✓ Properly maintain power tools to reduce exposure to vibration.
- ✓ Use gloves to protect against vibration and rough surfaces.
- ✓ Always practice proper machine handling.

1.1.2. Computer workstation ergonomics

Keyboards

Place the keyboard in a position that allows the forearms to be close to the horizontal and the wrists to be straight. That is, with the hand in line with the forearm. If this causes the elbows to be held far out from the side of the body then re-check the work surface height.

Chairs

Adjust the seat tilt so that you are comfortable when you are working on the keyboard. Usually, this will be close to horizontal but some people prefer the seat tilted slightly forwards. Your knees should be bent at a comfortable angle and greater than 90º flexion. If this places an uncomfortable strain on the leg muscles, or if the feet do not reach the floor, then a footrest should be used. The footrest height must allow your knees to be bent at 90º; the height of the footrest may need to be adjustable. Adjust the backrest so that it supports the lower back when you are sitting upright. A range of chairs is available.

Phones

Avoid cradling the phone between your head and shoulder when answering calls. If you need to use your computer at the same time, use a headset or the phone's hands-free/speaker-phone capabilities if the environment is suitable.

Monitors

Set the eye-to-screen distance at the distance that permits you to most easily focus on the screen. Usually this will be within an arm's length. Set the height of the monitor so that the top of the screen is below eye level and the bottom of the screen can be read without a marked inclination of the head. Usually this means that the center of the screen will need to be near shoulder height. Your eyes should be level with the tool bar.

Document holder

Place the document holder close to the monitor screen in the position that causes the least twisting or inclination of the head.

Desks

Adjust the height of the work surface and/or the height of the chair so that the work surface allows your elbows to be bent at 90º, forearms parallel with the floor, wrist straight, shoulders relaxed. Place all controls and task materials within a comfortable reach of both hands so that there is no unnecessary twisting of any part of the body. Most people prefer the document holder to be between the keyboard and the monitor. There are many different types of document holders available.

Lighting, glare and reflection

Lighting

Place the monitor to the side of the light source/s, not directly underneath. Try to site desks between rows of lights. If the lighting is fluorescent strip lighting, the sides of the desks should be parallel with the lights. Try not to put the screen near a window. If it is unavoidable ensure that neither the screen nor the operator faces the window.

If the monitor is well away from windows, there are no other sources of bright light and prolonged desk-work is the norm, use a low level of service light of 300 lux. If there are strongly contrasting light levels, then a moderate level of lighting of 400-500 lux may be desirable.

Glare and reflection

It is important to detect the presence of glare and reflection. To determine whether there is glare from overhead lights, sit down and hold an object such as a book above the eyes at eyebrow level and establish whether the screen image becomes clearer in the absence of overhead glare.

To detect whether there are reflections from the desk surface, hold the book above the surface and assess the change in reflected glare from the screen. You can eliminate or reduce the influence of these reflections in a number of ways:

- ✓ Tilt the screen (top part forwards) so that the reflections are directed below eye level.
- ✓ Purchase an LCD screen.
- ✓ Cover the screen with a light diffusing surface or anti-glare screen.
- ✓ Negative contrast screen (dark characters on light background) will reduce the influence of these reflections.

If you experience eye discomfort when using a bright screen, you should make the following adjustments:

- ✓ Turn the screen brightness down to a comfortable level.
- ✓ Look away into the distance in order to rest the eyes for a short while every 10 minutes or so.

- ✓ Change the text and background colors. We recommend black characters on white or yellow background, or yellow on black, white on black, white on blue and green on white. Avoid red and green and yellow on white.

Using a mouse

A well-designed mouse should not cause undue pressure on the wrist and forearm muscles. A large bulky mouse may keep the wrist continuously bent at an uncomfortable angle. Pressure can be reduced by releasing the mouse at frequent intervals and by selecting a slim-line, low-profile mouse. Keep the mouse as close as possible to the keyboard, elbow bent and close to the body.

Keyboard equipment and radiation

Computer screens emit visible light that allows the characters on the screen to be seen. Weak electromagnetic fields and very low levels of other radiation that are not visible to the human eye can be detected by sensitive instruments. Similar emissions are produced by television receivers.

The levels of most radiations and electromagnetic fields emitted from computers are much less than those from natural sources, such as the sun or even the human body, and are well below levels considered to be harmful by responsible expert bodies such as the International Radiation Protection Association (IRPA).

Posture while typing

Good posture is essential for all computer users. You should adopt a natural and relaxed position, providing opportunity for movement, from which you can assume a number of alternative positions. There is no single, rigidly defined position.

Typing technique

Typing is a physical activity, and using a keyboard requires skill, hence the need to learn correct typing technique. Unskilled ('hunt and peck') typists are particularly at risk of "occupational overuse injury" because they:

- ✓ often use only one or two fingers which may overload the finger tendons
- ✓ are constantly looking from keyboard to screen to keyboard, which may strain neck muscles
- ✓ often adopt a tense posture (wrists bent back and fingers 'poised to strike').

Speed of keying

The efficiency and speed of modern computers makes it possible for a skilled operator to type extremely quickly. This capability, reinforced by workload pressures, means the potential exists for operators to key at speeds which may cause or contribute to occupational overuse syndrome. The role of the repetitive movement in injury is not fully understood, but is believed to interfere with the lubrication capacity of tendons, and the ability of muscles to receive sufficient oxygen supplies. Ten thousand to 12,000 keystrokes per hour is considered an acceptable standard.

Length of time on the keyboard

The maintenance of a fixed posture for long periods is tiring and increases the likelihood of muscular aches and pains. In addition, long periods of repetitive movement and sustained visual attention can also give rise to fatigue-related complaints. It is recommended that operators take regular postural/stretching breaks to reduce intense periods of repetitive movement. Jobs should be designed and organized so that either:

- ✓ computer-related tasks can be interspersed with non-computer related, or
- ✓ computer based tasks can be rotated amongst several staff (task/job sharing).

Posture and environment

Change your posture at frequent intervals to minimize fatigue. Avoid awkward postures at the extremes of the joint range, especially the wrists. Take frequent short rest breaks rather than infrequent longer ones. Avoid sharp increases in work rate. Changes should be gradual enough to ensure that the workload does not result in excessive fatigue.

1.2. Anti-glare mechanism for high radiation screen

A glare is a bright light that causes trouble in seeing. For example, if you were to work on your laptop outside, it's likely you would encounter glare from the sun on your screen. To help prevent glare on computer screens and other electronics, use an anti-glare screen.

1.2.1. Ways to Stop Screen Glare

There are a number of ways to significantly reduce reflection and screen glare. In some cases, following these steps will eliminate glare and reflection entirely.

Adjust the Monitor Tilt

The easiest way to reduce some glare and related screen reflections is to simply adjust the display's tilt and swivel mechanisms. Adjust the monitor's tilt slowly, keeping an eye on reflections and glare. In most cases, you will eventually come across a relatively lag-free location for the monitor to rest. The same goes for swivel.

Tip: The easiest way to reduce some glare and related screen reflections to achieve monitor eye strain relief, is to simply adjust the display's tilt and swivel mechanisms.

Change the Background and Text Colors

Another relatively simple way to reduce glare and reflection is to change the monitor's background and to adjust the text colors. Generally speaking, one should use light characters on a dark background for minimal screen glare. Another option is to use white characters on a blue background. Either of these adjustments should limit reflections from outside sources onto your traditional or 3D monitor if you know what a 3D monitor is. As a warning, dark characters on a light background could increase screen glare.

Tip: Another relatively simple way to reduce glare and reflection is to change the monitor's background and to adjust the text colors

Warning: As a warning, dark characters on a light background could increase screen glare

Improve Lighting

If household lighting fixtures are adding to your screen glare problem, then it may be time to change up your lights. Use indirect lighting and task lights for the best results and try to stick to lights that offer brightness adjustability options. Also, try to avoid sitting with overhead lights directly in your field of view, as this can increase reflections.

Tip: Use indirect lighting and task lights for the best results and try to stick to lights that offer brightness adjustability options

Warning: Also, try to avoid sitting with overhead lights directly in your field of view, as this can increase reflections.

Accessories and Add-ons

There are a number of third-party accessories and add-ons that are designed to reduce or eliminate screen glare and unwanted reflections. One such item is called a glare guard, which can be affixed to the edges of the monitor. A similarly designed option is called a monitor visor.

Tip: There are a number of third-party accessories and add-ons that are designed to reduce or eliminate screen glare and unwanted reflections, including a great blue light screen monitor if you're concerned about eye strain and fatigue.

Warning: Make sure to do your research to ensure that the accessory or add-on can easily fit on to your display. If you're shining a light on a highly polished glass surface, about 96 percent of the light will go straight through, and four percent will be reflected. By adjusting the screen brightness to a proper level that does not cause eye fatigue, you can reduce blue light by a total of 60-70%.

1.2.2. Anti-glare Vs Anti-reflection

The purpose of the Anti-Glare and Anti-Reflective screen is to enhance the readability of the devices, primarily under direct sunlight. These two solutions allow users the read displayed image or set of the characters with the least amount of the eye strain. The difference between those solutions lies in the mechanism they use.

Anti-Glare deals with external sources of reflection off a surface – like bright sunlight or high ambient lighting conditions – and its impact on the readability of the image or information you are trying to read. To deal with the external sources of reflection, Anti-Glare uses diffusion mechanisms to break-up the reflected light off the surface. Diffusion works by reducing the coherence of the reflected image, making these unwanted images unfocused to the eye, thereby reducing their interference with viewing of the intended image contained in the display

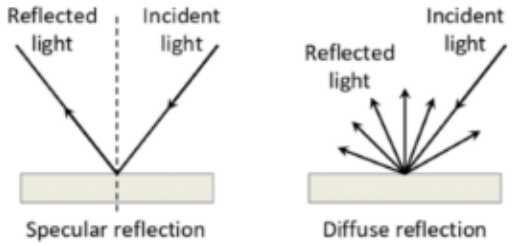


Figure 1. 1: Anti-glare diffusion mechanism

Anti-Reflation

Unlike diffusion-based anti-glare solutions, Anti-Reflection considers all sources, both internal and external, that accumulate to reduce the light transmitted through the display window, thereby reducing the readability of the viewed image or information. As light passes from one medium to another, be it from air to solid or between solid layers, the difference between the "index of refraction" in the adjacent mediums creates transitional phase differences, thereby increasing the amount of light reflected. These reflections are cumulative, and can "wash out" the display, making the image unreadable without increasing the light output via expensive power increases.

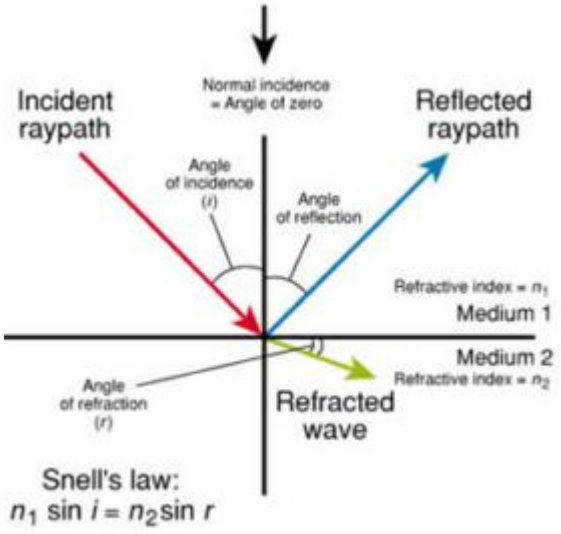


Figure 1. 2: Anti-reflection index of refraction

1.3. Electrical Drawing Software Packages

1.3.1. Introduction

Software is a set of instructions, data or programs used to operate computers and execute specific tasks. It is the opposite of hardware, which describes the physical aspects of a computer. Software is a generic term used to refer to applications, scripts and programs that run on a device.

The main characteristics of software are:

- ✓ ***Functionality***— This is the ability of software to perform and operate functions they are designed for. All types of software are designed to provide users with the desired functionality that they must be able to meet.

- ✓ ***User-friendliness*** — User-friendliness of software refers to its ease of use. Software should be simple and user interface friendly for smooth operations. Software designed with a smooth flow and user-friendly interface is much more efficient, even for people with no IT background.
- ✓ ***Efficiency***— Software utilizes both human and systems resources efficiently. Such resources include time, effort, memory, Central Processing Units (CPU), databases, etc. Despite the excellent features a software may have, it must efficiently use storage and respond promptly to commands.
- ✓ ***Flexibility***— A software can adapt to future changes in its component requirements. The software can accept modifications, addition, or removal of features without halting its initial operation mode of operation.
- ✓ ***Portability***— A software can and should be able to function on different dynamics of platforms. It should be easy to install and use without significant interference from one platform to another.

Some of the essential functions of software include:

- ✓ Enable computer users to access the information they desire from the computers.
- ✓ Enable computers to carry out data comparisons, make logical decisions, do arithmetic calculations, store data, and retrieve and carry out sequential operations.
- ✓ Some software functions translate a program written in other languages into a language that computers can understand.
- ✓ Enable computers to work towards giving user-desired outputs.

The two main categories of software are application software and system software.

System Software: System Software (a type of computer program) provides a platform to run computer's hardware and computer application to utilize system resources and solve their computation problem. It is written in a low-level language, like assembly language so it can easily interact with hardware with basic level. It controls working of peripheral devices. System software act as a scheduler for the execution of the processes and arrange the sequence according to their priority and I/O devices requirement and creation of the process. The best-known example of system software is the operating system (OS). It responsible for manages all the other programs on a computer.

Application Software: Applications software is capable of dealing with user inputs and helps the user to complete the task. It is also called end-user programs or only an app. It resides above system software. First user deal with system software after that he/she deals with application software. The end user uses applications software for a specific purpose. It programmed for simple as well as complex tasks. It either be installed or access online. It can be a single program or a group of small programs that referred to as an application suite.

Common types of Application Software

- ✓ **Presentation Software:** Presentation program is a program to show the information in the form of slides.
- ✓ ***Spreadsheet Software:*** Spreadsheet software is used to perform manipulate and calculations.
- ✓ ***Database Software:*** Database is a collection of data related to any applications. Database Management System (DBMS) software tool used for storing, modifying extracting and searching for information within a database. MySQL, MS Access, Microsoft SQL Server and Oracle is the example of database application Software.
- ✓ ***Multimedia Software***: Multimedia is a combination of text, graphics, audio and Multimedia software used in the editing of video, audio and text. Multimedia software used in the growth of business, educations, information, remote system and entertainment.
- ✓ ***Simulation Software:*** Simulation is an imitation of real world and environment. The simulation creates a physical environment of the real world to represent the similar behavior, function and key nature of the selected topic. Simulation is technology for education, engineering, testing, training, video games and for scientific modelling of natural systems to gain insight into their functioning. The simulation used in the area of the real world where the real system cannot be accessible or may be dangerous or unacceptable. Area of technology flight, economics, automobiles, Robotics, digital lifecycle, Space Shuttle Navigation, weather.

1.3.2. Electrical software package tools

There are different forms of simulation software's that can be used in electrical technologies fields. Some of the software's are; Proteus, CAD, Visio, Arduino software.

1. Proteus

Is a simulation and design software tool developed by Lab center Electronics for Electrical and Electronic circuit design. It also possesses 2D CAD drawing feature. It is a software suite containing schematic, simulation as well as PCB designing.

- ✓ **ISIS** is the software used to draw schematics and simulate the circuits in real time. The simulation allows human access during run time, thus providing real time simulation.
- ✓ **ARES** is used for PCB designing. It has the feature of viewing output in 3D view of the designed PCB along with components.
- ✓ The designer can also develop 2D drawings for the product.

Features

ISIS has wide range of components in its library. It has sources, signal generators, measurement and analysis tools like oscilloscope, voltmeter, ammeter etc., probes for real time monitoring of the parameters of the circuit, switches, displays, loads like motors and lamps, discrete components like resistors, capacitors, inductors, transformers, digital and analog Integrated circuits, semi-conductor switches, relays, microcontrollers, processors, sensors etc.

ARES offers PCB designing up to 14 inner layers, with surface mount and through hole packages. It is embedded with the foot prints of different category of components like ICs, transistors, headers, connectors and other discrete components. It offers Auto routing and manual routing options to the PCB Designer. The schematic drawn in the ISIS can be directly transferred ARES.

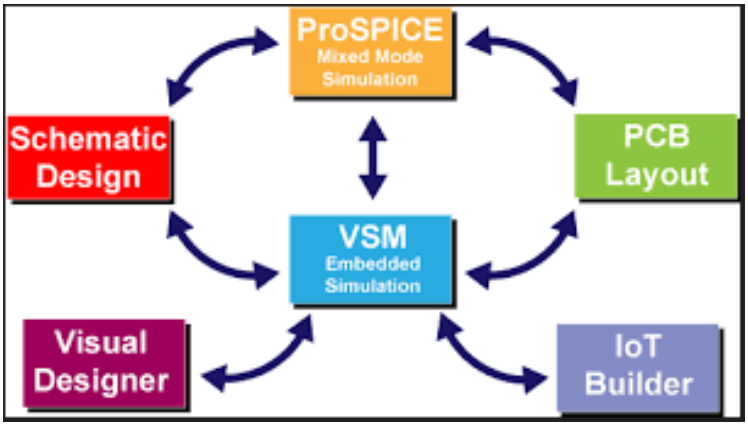


Figure 1. 3: Product structure diagram of Proteus software

Product Modules

The Proteus Design Suite is a Windows application for schematic capture, simulation, and PCB (Printed Circuit Board) layout design. It can be purchased in many configurations, depending on the size of designs being produced and the requirements for microcontroller simulation. All PCB Design products include an autoroute and basic mixed mode SPICE simulation capabilities.

Schematic Capture

Schematic capture in the Proteus Design Suite is used for both the simulation of designs and as the design phase of a PCB layout project. It is therefore a core component and is included with all product configurations.

Microcontroller Simulation

The micro-controller simulation in Proteus works by applying either a hex file or a debug file to the microcontroller part on the schematic. It is then co-simulated along with any analog and digital electronics connected to it. This enables its use in a broad spectrum of project prototyping in areas such as motor control, temperature control and user interface design. It also finds use in the general hobbyist community and, since no hardware is required, is convenient to use as a training or teaching tool. Support is available for co-simulation of:

- ***Microchip Technologies*** PIC10, PIC12, PIC16, PIC18, PIC24, dsPIC33 microcontrollers
- ***Atmel AVR (and Arduino)***, 8051 and ARM Cortex-M3 microcontrollers
- ***NXP 8051, ARM7, ARM Cortex-M0 and ARM Cortex-M3 microcontrollers***
- ***Texas Instruments*** MSP430, PICCOLO DSP and ARM Cortex-M3 microcontrollers
- ***Parallax Basic Stamp, Freescale HC11, 8086 microcontrollers***

PCB Design

The PCB Layout module is automatically given connectivity information in the form of a netlist from the schematic capture module. It applies this information, together with the user specified design rules and various design automation tools, to assist with error free board design. PCB's of up to 16 copper layers can be produced with design size limited by product configuration.

3D Verification

The 3D Viewer module allows the board under development to be viewed in 3D together with a semi-transparent height plane that represents the boards enclosure. STEP output can then be used to transfer to mechanical CAD software such as Solid works or Autodesk for accurate mounting and positioning of the board.

2. E-CAD

The term CAD (Computer Aided Design) applies to a wide range of programs that allow the user to created drawings, plans, and designs electronically. The use of AutoCAD-Electrical for creation of electrical control schematics for single and three phase alternating current (AC) as well as Direct Current (DC) applications, will also enables to defining a control panel layout with the different components to accommodate in it, with the industry standard Ladder diagram, PLCs and with different form of report types.

Advantage of E-CAD

- ***Increase Productivity***

AutoCAD Electrical software is for controls designers, it contains many features and benefits that enable users to dramatically increase design efficiency, while maintaining a smooth integration with the familiar AutoCAD environment.

- ***Reduce errors and comply with industry standards***

AutoCAD Electrical includes automatic error-checking capabilities that help designers perform real-time diagnostics to catch problems before the build phase of a project.

- ***Manage design data***

Once the design is complete, it is important to share accurate design and part information with manufacturing. Creating crucial parts lists, BOMs, and from/to wire lists using software that is not built specifically for these tasks can waste valuable time and resources. AutoCAD Electrical includes robust automated reporting tools so the design data being shared with downstream users is correct and current.

- ***Facilitate collaborations***

AutoCAD Electrical enables both electrical and mechanical teams to work collaboratively by making it easy to share the electrical design intent for cables and conductors directly with team members, adding valuable electrical controls design data to the digital prototype.

Applications of E-CAD

- ✓ ***Generate manufacturing documentation***, which is released to manufacturing as part of the specification used to source, fabricates and produces PCBs.
- ✓ ***Diagramming*** capabilities allow engineers to define what electronic components are used and what signals are used to connect them. Engineers select components from a company-standardized library that is centrally controlled.
- ✓ ***Layout*** capabilities provide a means to create the PCB's outline and dimensionally place components within its boundaries. The list of electronic components used in the diagram is carried over to the layout, where it almost becomes a to-do list for placement.
- ✓ ***Automation*** capabilities, which automatically routes traces from components to components based on interconnect information, is available. This can be done initially and then customized.
- ✓ ***Bill of Material (BOM)*** capabilities automatically generates the list of electrical components for the PCB.

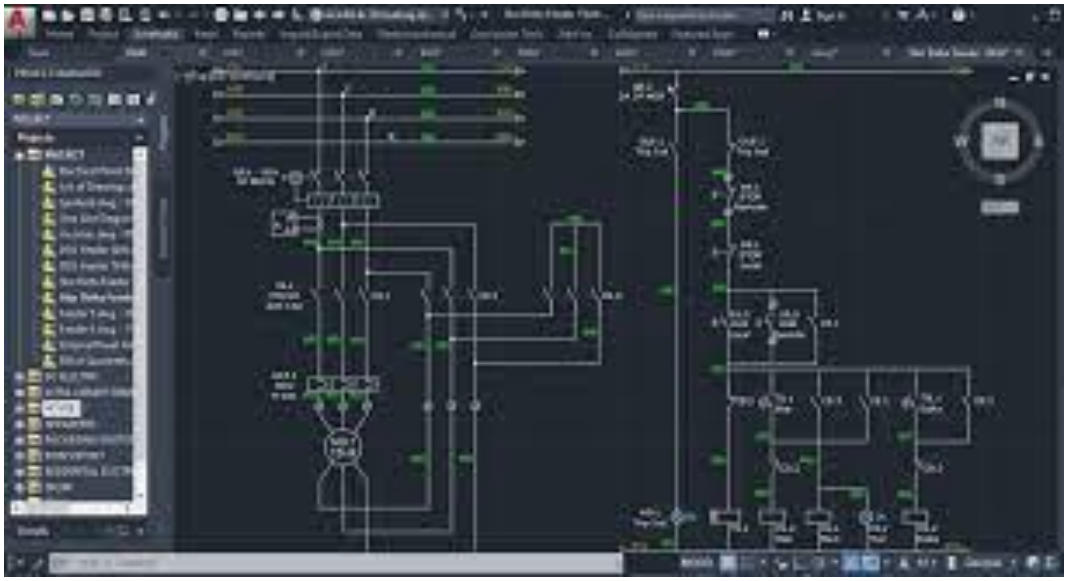


Figure 1. 4: Electrical Design using E-CAD Software

3. Visio

Computer diagramming is the process of creating scalable diagrams on a PC that can be used in various applications such as layout design, organization charts, timelines, floor plans and even prototype

software user interfaces. Diagrams are made of shapes, objects and stencils, which when combined together correctly, can help project a lot of useful information.

Computer diagramming can be shape-based artwork or more complex drafting often seen in CAD (Computer Aided Design) programs. CAD contains a lot more information such as the materials, processes, and specific conventions of the diagram. Shape-based artwork is more commonly used to depict lesser technical information.

Microsoft Visio is one of the most popular diagramming software that empowers diagramming, data visualization, and process modelling in a familiar interface. Visio comes with an array of templates and built-in shapes that allow creating virtually any diagram of any complexity. Visio also allows users to define their own shapes and import them into the drawing.

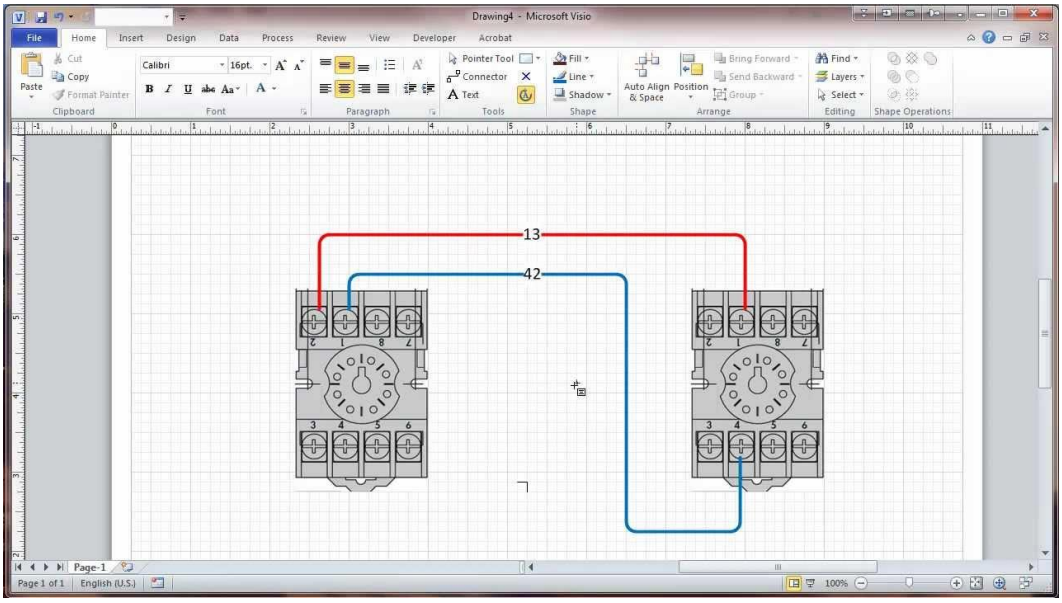


Figure 1. 5: Circuit design using Visio software

4. Arduino

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

Figure 1. 6: Arduino Family

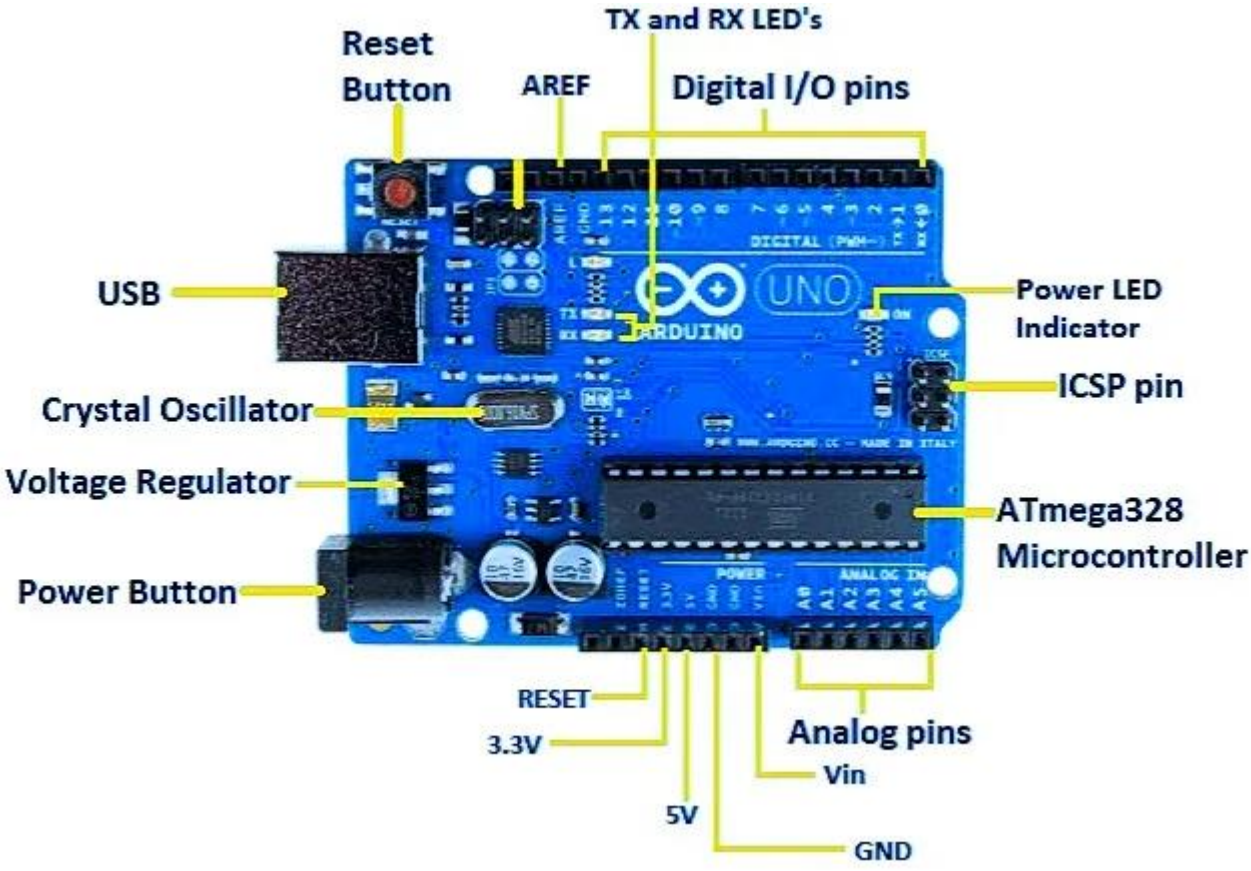


Figure 1. 7: Arduino pin configuration

Arduino simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students, and interested amateurs over other systems:

- ✓ ***Inexpensive*** - Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled by hand, and even the pre-assembled Arduino modules cost less than \$50
- ✓ ***Cross-platform*** - The Arduino Software (IDE) runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows.
- ✓ ***Simple, clear programming environment*** - The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them. For teachers, it's conveniently based on the Processing programming environment, so students learning to program in that environment will be familiar with how the Arduino IDE works.

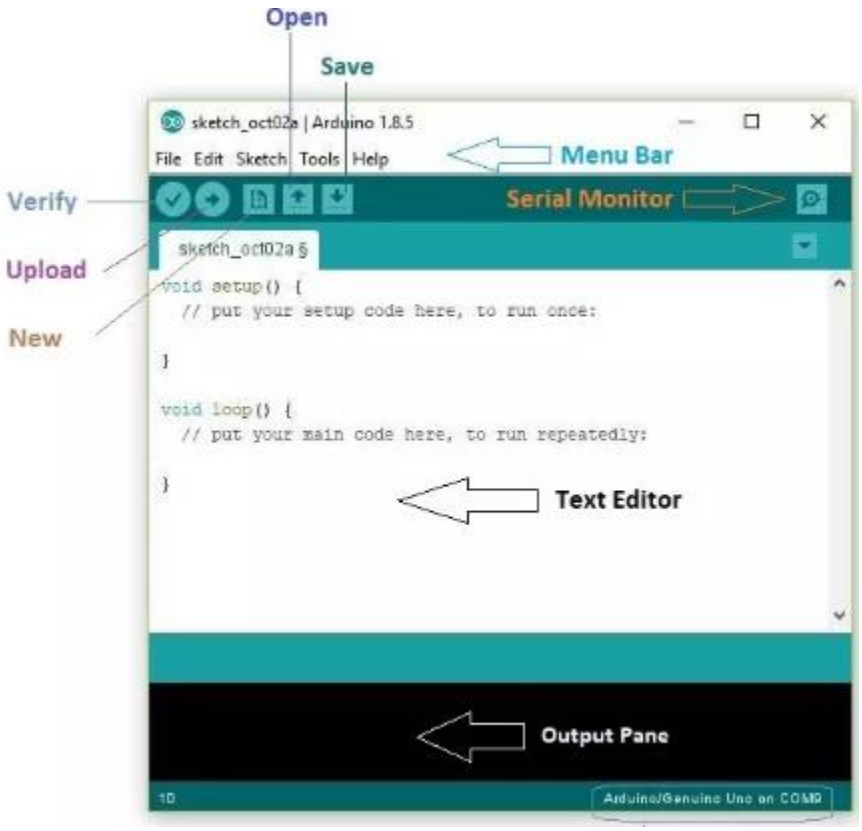


Figure 1. 8: Arduino IDE software

- ✓ ***Open source and extensible software*** - The Arduino software is published as open-source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based. Similarly, you can add AVR-C code directly into your Arduino programs if you want to.
- ✓ ***Open source and extensible hardware*** - The plans of the Arduino boards are published under a Creative Commons license, so experienced circuit designers can make their own version of the module, extending it and improving it. Even relatively inexperienced users can build the breadboard version of the module in order to understand how it works and save money.

Self-check-1.1

Part I: Matching

Direction: match column A with column B. writes your answer on the space provided before the number.

Column A	Column B
_____ 1. Presentation software	A. Used in editing of videos, audios and texts.
_____ 2. Application software	B. Manipulation and calculation of data
_____ 3. Multimedia software	C. Operating system
_____ 4. Spreadsheet software	D. Collection of data related to any application
_____ 5. System software	E. Proteus
	F. Shows information in the form of slides

Part II: Identification

Direction: From the given alternatives write the correct answer on the space provided for each of the following questions.

Software **Glare** **Anti-Glare**

Accessories **Ergonomics**

1. _____ is a set of instructions, data or programs used to operate computers and execute specific tasks.
2. _____ is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system.
3. _____ is a bright light that causes trouble in seeing.

Part III: Enumeration

Direction: write or list down the following.

1. Common types of application software

   a) _____

   b) _____

   c) _____

d) _____

e) _____

2. Benefits of Ergonomics

a) _____

b) _____

c) _____

3. Main characteristics of software's

a) _____

b) _____

c) _____

d) _____

e) _____

4. Advantages of E-CAD

a) _____

b) _____

c) _____

d) _____

Unit Two Selecting and using of electrical drawing software packages

This unit to provide you the necessary information regarding the following content coverage and topics:

- Selecting electrical drawing software packages
- Document Purposes and organizational requirements
- Matching document requirements with Electrical drawing software
- Determining Design, drawings and layouts required
- Developing electrical drawing using electrical software

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Select electrical drawing software packages properly
- Identify document Purposes and organizational requirements
- Match document requirements with Electrical drawing software
- Determine Design, detailed drawings and layouts required
- Develop electrical drawing using electrical software

2.1. Selecting electrical drawing software packages

When selecting the best software for electrical drawings, making the right choices can deliver big benefits not only at the design stage, but through every phase of a project through to installation, commissioning and beyond. Evaluating a wide range of emerging options requires the development of software selection criteria to ensure that products are the best fit for the varied needs of the users and are in alignment with a sustainable business model.

2.1.1. Software selection Criteria

The following selection criteria can serve as a starting point for any software assessment. Criteria are organized into a set of six broad categories.

Capital (startup) costs

- ✓ How much does the product cost?
- ✓ How easy is it to install the product?
- ✓ What are costs for any additional hardware, software, or server space needed to operate the product?
- ✓ What degree of installation support is available from the vendor, and is there any additional charge for this support?
- ✓ Are there any training or consulting costs in helping project staff become familiar with the system?
- ✓ What is the learning curve for project staff in adapting to the new system (length of time)?
- ✓ What changes are needed to make the standard product fit the needs of the project/users (fit-for-purpose)?
- ✓ What cost would be incurred to customize the standard product?
- ✓ Are programmers widely available with specialized knowledge or familiarity with the product?
- ✓ Is source code provided so customizations or modifications can be made without large costs?
- ✓ Do customizations hamper upgrade to future software releases?
- ✓ How many users can be served by the software, and what is the cost for scaling the project up to meet increased demand?

Operating costs

- ✓ What level of maintenance is needed to operate the system in an ongoing basis?
- ✓ What are the annual maintenance charges for the software, and are they reasonable?
- ✓ What are the costs in adding or updating data used by the software?

- ✓ Can our server administrators work with the product?

Functions/features

- ✓ How well does it meet the needs of the user community?
- ✓ How well does it meet the needs of the project team?
- ✓ Does it accept and use common file formats (or is a conversion necessary)?
    - Are file formats proprietary?
    - How easily is data importable/exportable?
    - How well does it work with existing software currently in use?
- ✓ How difficult is it to administer security and permissions?
- ✓ Is support for metadata offered?
- ✓ Is there an administrative module available allowing for easy site management?
- ✓ Is data secure?
- ✓ Does the software allow compliance with terms of data sharing agreements?
    - How/where is data stored?
    - Who hosts the data, and where are servers located?
    - Who owns the software?

Reliability

- ✓ Is the technology mature, or has the technology been proven to meet the needs of similar clients?
- ✓ What major changes/upgrades are planned?
- ✓ How long has the product been in existence, and how many versions of the software have been released?

Usability

- ✓ Are help features/documentation offered to the users through the software?
- ✓ What degree of training is required for end users (how intuitive is the software)?

Vendor

- ✓ Who else is using the technology (how large is the user community - especially important with open source)?
- ✓ How stable is the vendor?
    - Length of time in business?
    - Company size/revenue?

- Number of customers (local and national), including recent change?

✓ Does the vendor have a proven track record?

✓ Does the vendor have the ability to provide support to users?

- What types of support are offered?

✓ Is the company providing the technology likely to be around for the long-haul?

- What are the implications if it is not?

2.2. Document purposes and organizational requirements

The task of determining document needs for an organization is complex. It will require you to find out the requirements and capabilities of the organization and to communicate with a wide range of people to:

✓ identify the types of documents required

✓ determine entry, storage and quality needs

✓ determine information technology capability

✓ establish standards.

To do this you will be required to already have skills in computer operation, word processing and keyboarding, research and analysis, literacy and the ability to communicate with a diverse range of people in the workplace.

Every organization has an image it would like to portray. Documents are key internal and external communication tools. Some levels of consistency and standards of information quality are required to ensure the desired message and tone is achieved.

Each new letter should be based on a style that has gone before. Of course, letters, like memos or faxes, have a standard form established over many years of business communication. Software packages often provide templates (standard forms) to help you present consistent document styles.

Organization requirements

Some organizations have information on their requirements presented in a style guide or procedures manual. These may set down the standards for:

✓ visual presentation, including margins, fonts and style

✓ spelling, grammar, punctuation and writing style

- ✓ graphics standards, including the use of logos and brands
- ✓ document naming conventions and filing protocols.

A style guide or procedures manual enables an organization to achieve consistency and quality in its documentation, enables staff to efficiently produce material without having to spend time thinking about style issues and enables the organization to have control over the image presented by its communications. In small organizations, these guides may not exist. In this case, a new member of staff should check the style and layout of previous documents or ask for advice on the usual practices from more experienced colleagues.

Costs

It is important to use the most efficient ways to produce documents and to customize hardware and software to reduce production time and achieve maximum efficiency. Costs to consider include:

- ✓ the cost of the operator's time spent keying in information, checking, correcting and printing the document
- ✓ the cost of stationery
- ✓ the effectiveness of hardware, including operating speed and configuration for optimum performance
- ✓ the effectiveness of software, which must allow for simple and fast input, manipulation and output of data.

Appropriate technology now and in the future

In many organizations you will not have the opportunity or responsibility to identify appropriate hardware, as this will be installed by experienced IT staff. Even if you do not have responsibility for purchasing and installing software, you would expect to have access to suitable programs to produce the range of documents required. These may include word processing software such as Microsoft Word or Corel WordPerfect: layout software such as Adobe PageMaker or Quark Express: spreadsheets, such as VisiCalc or Microsoft Excel: and databases such as File maker Pro or Microsoft Access. You will need to identify the most appropriate types of software to satisfy particular requirements.

2.3. Matching document requirements with Electrical drawing software

Electrical Schematic Design

An electrical schematic is a logical representation of the physical connections and layout of an electric circuit. A well-documented schematic outlines the functionality of an electric circuit and provides the basis for assembly and troubleshooting of a system. A schematic can contain few or many symbols and connections and is normally read from left to right, top to bottom. Schematic manages all design data including affiliated documents, such as bill of materials and connection lists or assembly instructions and datasheets. Its object-oriented data structure ensures manufacturing instructions always match the design data. An intelligent component-based parts library ensures only real parts are used and helps drive the design with automatic part selections.

Cost and Importance of Documentation in Engineering

Poorly written work instructions, standard operating procedures, incorrect drawings and blueprints, improperly constructed fixtures, inappropriate production equipment, and poorly designed work station layout are just a few examples which contribute to human error. These poorly written documentations add addition trouble that could've been avoided. It is not unheard of to find components being fabricated according to out-of-date instructions because the correct information has been delayed in reaching the worker. Poor design and documentation quality is a major cause of product process inefficiencies, leading directly to delays, rework and variations, and contributing to increase project time and cost, for both the client and your company.

The quality of the design and documentation produced has a major influence on the overall performance and efficiency of production projects. Designers provide the basic blueprints for representing the ideas and concepts that manufacturers need to make products a reality. However, it is the quality of the documentation provided which determines how effective and efficient turnaround time is for production. Inadequate and deficient design and documentation impacts the production process efficiency by leading to delays, rework and variations, contributing to increases in project time and cost.

Documentation Categories

There are a countless number of documentations used throughout every company. They can range from quality assurance to manufacturing. Without running through a complete list of all the documentation that a company would use, we will instead sum the documentation into several categories below.

- ✓ ***Management documentation*** includes scheduling, supporting, and planning documents, organizational documentation and meeting minutes.
- ✓ ***Quality assurance documents*** include quality assurance policy and the procedures, definitions, standards, templates and instructions defined to support the handling of all documents, to ensure that the documents are prepared consistently and maintained to support development optimally.
- ✓ ***Design and Engineering documentation*** include the engineering specifications, engineering drawings, technical illustrations and are prepared to establish the design. These documents form the basis for development that are carried out by institutes, contractors, suppliers, and manufacturing. The designs and engineering of projects is a complex and challenging process, and its success is heavily reliant upon good communication between members of the design and engineering teams. Good design is effective when it serves its intended purpose and is produced within a desired budget, time constraints, and safely. To effectively communicate the design to manufacturing personnel requires a document to clearly define in great detail in the matter of producing it, effectively and without hindrance. The communication of the current design documentation, for example consists typically of a 2D or 3D generated drawing, showing the physically structure, along with specifications showing production and installation process. Issues arise when the following happens:
    - Necessary information appears to be missing for the design drawings.
    - Incomplete information of specifications
    - Discrepancies within the design drawing plans and details between drawings and specifications.
    - Methods for production are not possible and manufacturing request the use of alternate solutions.
- ✓ ***Fabrication, Assembly, Test, and Installation documents*** are prepared to support and document the development and validation of the equipment, in particularly those that are developed and manufactured for completion.

The Cost of Poor Communication

Overall, documentation is designed to be a means of communicating information between peers and workers. They provide valuable information that can answer countless questions for others to complete their work. Documentation is important to keep up-to-date, consistent, and complete. Documents that

are not coherent affect production efficiency and turnaround time completion. Poor documentation can result in the following:

- Rework
- Delays
- Re-design
- Failure Analysis/troubleshooting
- Retesting and re-inspection
- Equipment Downtime

These matters can come from poor management or engineering documentation and cause issues like:

- Customer Complaints
- Damaged Reputation
- Repairing Goods and Redoing Services
- Extra Setups and Disrupted Production Schedules
- Lost Management Time and Unexpected Overtime

2.4. Determining design, drawings and layouts required.

The electrical plan is sometimes called as electrical drawing or wiring diagram. It is a type of technical drawing that delivers visual representation and describes circuits and electrical systems. It consists of electrical symbols and lines that showcase the engineer's electrical design to its clients. In short, an electrical plan describes the position of all the electrical apparatus.

An electrical drawing may include all of these essential details described below:

- ✓ Interconnection of electrical wires and other parts of the system
- ✓ Connection of different components and fixtures to the system
- ✓ Power lines with details such as size, voltage, rating, and capacity
- ✓ Power transformers and also their winding connections
- ✓ The main switches, tiebreaker, and fused switches
- ✓ Other essential equipment such as solar panels, batteries, generators, air conditioning, and so on.

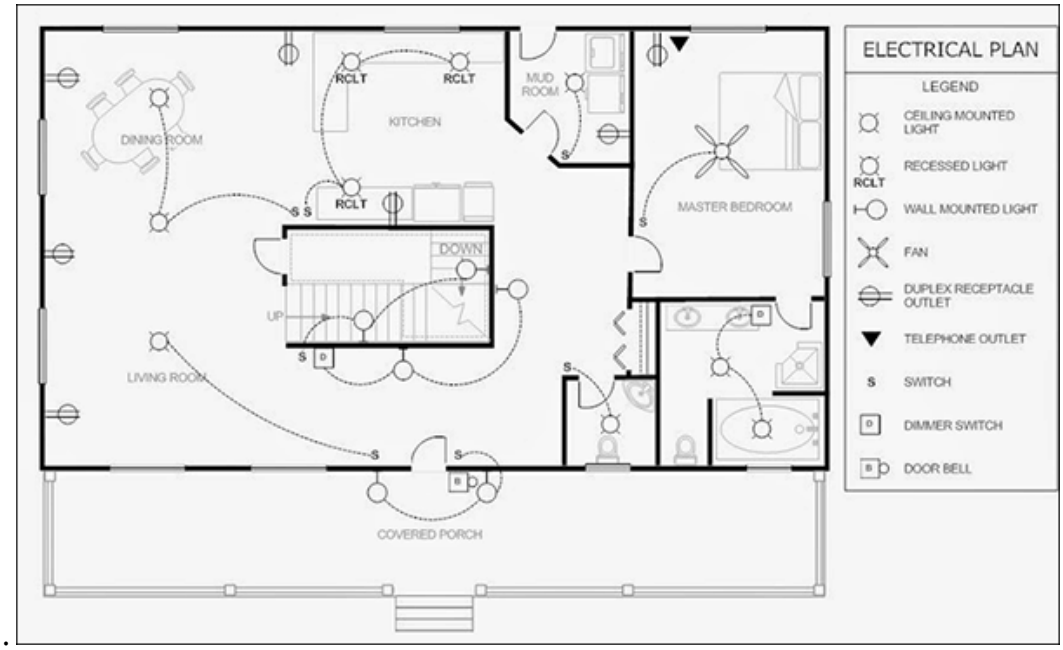


Figure 2. 1: Sample electrical plan

2.4.1. Purposes and Benefits of Electrical Plan

Purposes of Electrical Plan

- ✓ Drawings are vital for documenting, communicating information, and troubleshooting your power systems on-site.
- ✓ Accurate and updated drawings keep your building in compliance with all the code regulations.
- ✓ A plan encompasses all aspects. It focuses on areas such as lighting, electronics, appliances, etc.
- ✓ It also considers the structure of the building. For example, if a building has railings, stairs, or any other components, modifications will be made accordingly.
- ✓ It is a thorough planning tool because it gives an in-depth view of your building's electrical and wiring system.
- ✓ It helps to distribute power to various appliances and equipment through accurate operation and installation of elements.

Benefits of Electrical Plan

- ✓ A plan highlights all the potential risks to make amendments quickly before the occurrence of any substantial damage.

- ✓ It helps to ensure that your system runs safely, efficiently, and smoothly.
- ✓ An electrical plan saves time by avoiding delays and problems. A draft pinpoint everything to prevent hazardous situations; thereby, it helps professionals to complete their work on time.
- ✓ It also saves money because nobody feels like spending more money than they already have. A draft includes all the details like wire's length, type of cables, and other parts you will need to complete your project. Thus, you do not have to spend a considerable amount of money on unnecessary things.
- ✓ An electrical plan prevents injury because it pinpoints all the building's anticipated areas that may harm a technician.

2.4.2. Types of Electrical Diagrams and Drawing

In Electrical and Electronics Engineering, we use different types of drawings or diagrams to represent a certain electrical system or circuit. These electrical circuits are represented by lines to represent wires and symbols or icons to represent electrical and electronic components.

a. Block Diagram

A block diagram is a type of electrical drawing that represents the principal components of a complex system in the form of blocks interconnected by lines that represent their relation. It is the simplest form of electrical drawing as it only highlights the function of each component and provides the flow of process in the system. It lacks the information about the wiring and placement of individual components. It only represents the main components of the system and ignores any small components. This is why; electricians do not rely on block diagram.

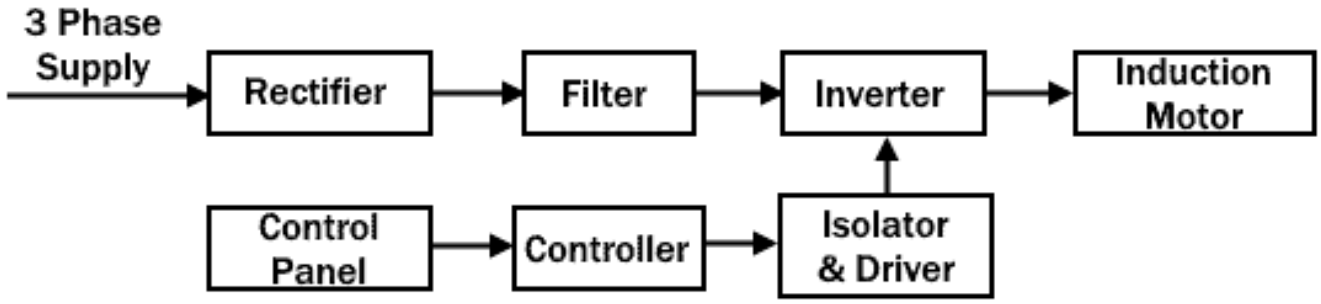


Figure 2. 2: Block diagram of a typical variable frequency driver

This block diagram shows a 3 phase AC power supply conversion into a DC which is again converted into a controlled AC supply. It is quite a complicated process but this diagram simplifies the process into

blocks for better understanding. The block diagram provides an idea how the process is done by not delving too deep into the electrical terms but it is not enough to implement a circuit.

b. Schematics Circuit Diagram

The schematic diagram of an electrical circuit shows the complete electrical connections between components using their symbols and lines. Unlike wiring diagram, it does not specify the real location of the components, the line between the components does not represent real distance between them. It is the most common type of electrical drawing and are mostly used in implementing electrical circuits by technician. Most engineering student rely of schematic diagram while developing various electrical projects.

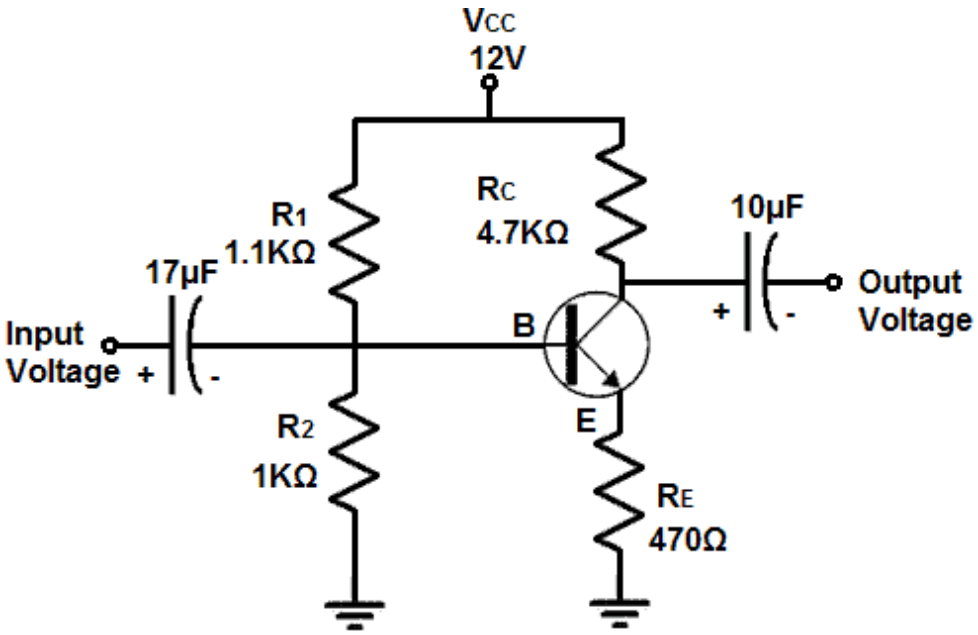


Figure 2. 3: Schematic diagram of a voltage amplifier

c. Single Line Diagram or One-line Diagram

Single Line diagram (SLD) or one-line diagram is the representation of an electrical circuit using a single line. As the name suggests, a single line is used to denote the multiple power lines such as in 3 phase system. Single line diagram does not show the electrical connections of the component but it may show the size and ratings of the components being used. They are used for determining and isolating any faulty equipment in any power system during troubleshooting.

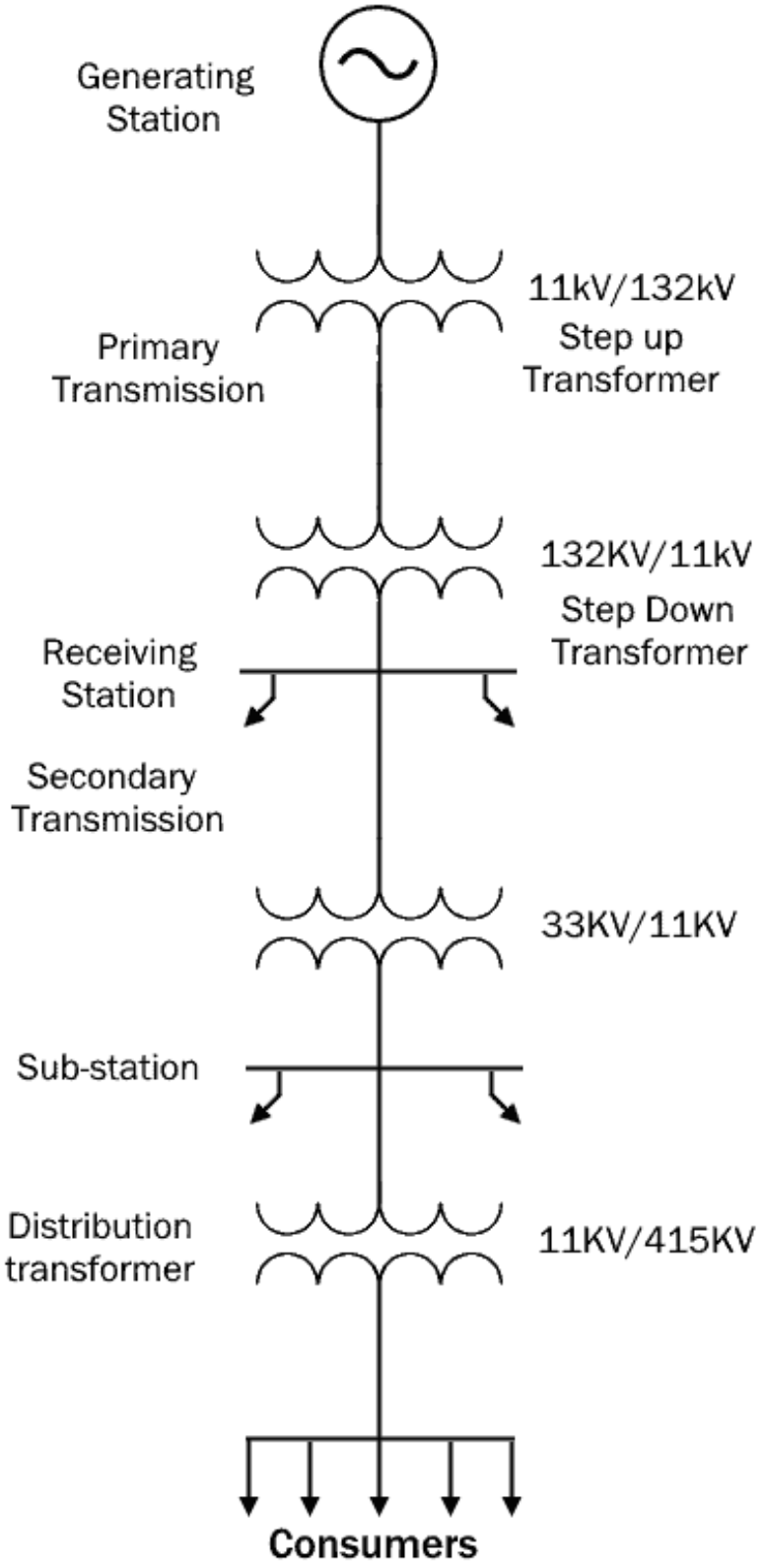


Figure 2. 4: Single line diagram of power transmission

d. Wiring Diagram

The wiring diagram is used for the representation of electrical components in their approximate physical location using their specific symbols and their interconnections using lines. Wiring diagram shows a pictorial view of the components such that it resembles its electrical connection, arrangement and position in real circuit. It really helps in showing the interconnections in different equipment such as electrical panel and distribution boxes etc. they are mostly used for wiring installation in home and industries.

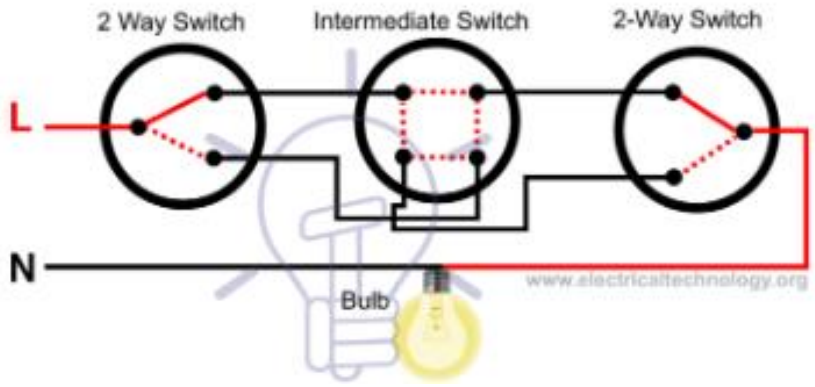


Figure 2. 5: Wiring diagram of three-way switch

e. Pictorial Diagram

The pictorial diagram does not necessarily represent the actual circuit. In fact, it shows the visual appearance of the circuit in real time. it cannot be used to understand or troubleshoot the actual circuit and for this reason alone, it is not commonly used. For someone with less knowledge of electrical, it is impossible to understand how the circuit works and diagnose it.

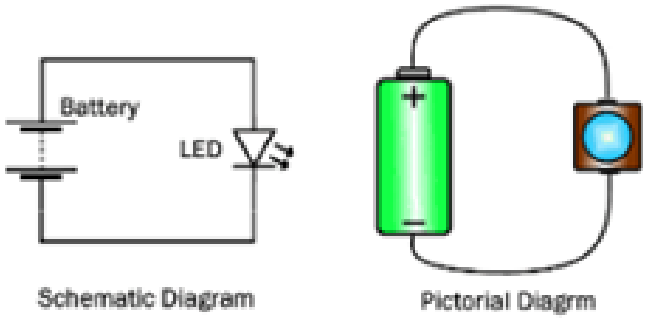


Figure 2. 6: Sample pictorial diagram of LED circuit

f. Ladder Diagram or Line Diagram

Ladder diagram are electrical diagrams that represents an electrical circuit in industries to document control logic systems. It resembles a ladder which is why it is named ladder diagram. There are two vertical lines; the left vertical line represents power rail (voltage source) while the right vertical line represents the ground or neutral. Each horizontal row represents a parallel circuit called rung. A ladder diagram is simple, easier to understand and helps in troubleshooting the circuit quickly.

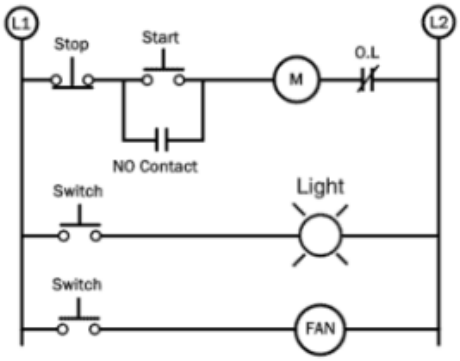


Figure 2. 7: Sample ladder diagram

g. Logic Diagram

Logic diagram represents a logic circuit by showing complex circuit and process using various blocks or symbols. The logic functions are represented by their logic symbols whereas the blocks are used to represent complex logic circuit. The logic diagram does not show the electrical characteristics of a circuit such as current, voltage or power etc. it only represents the logical function of the circuit or device where the signal is considered in binary format i.e., 1 or 0. Logic diagram are commonly used in digital logic designing.

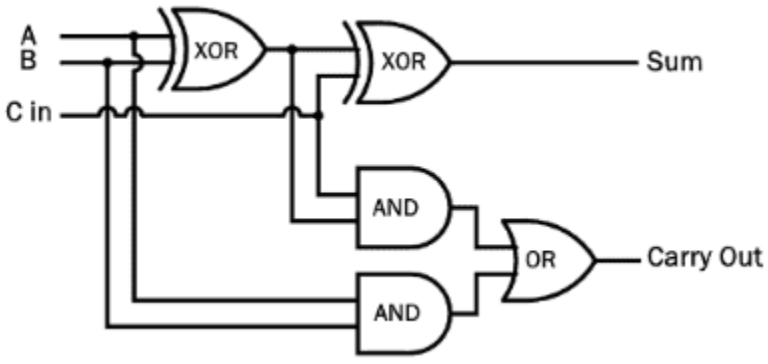


Figure 2. 8: Logic diagram of Full-Adder circuit

2.5. Developing electrical drawing using electrical software

Computer-aided design (CAD) can be defined as the use of computer systems to assist in the creation, modification, analysis, or optimization of a design. The computer systems consist of the hardware and software to perform the specialized design functions required by the particular user firm. The CAD hardware typically includes the computer, one or more graphics display terminals, keyboards, and other peripheral equipment. The CAD software consists of the computer programs to implement computer graphics on the system plus application programs to facilitate the engineering functions of the user company.

Electrical drawings are absolutely crucial for documenting, troubleshooting, and communicating information about your power systems on your site. They can help to ensure your system runs smoothly, efficiently, and most importantly: safely. They can even help you highlight potential risks that you can correct before a problem occurs.

2.5.1. Symbols used in electrical drawings

Circuit layouts and schematic diagrams are a simple and effective way of showing pictorially the electrical connections, components and operation of a particular electrical circuit or system. Basic electrical and electronic graphical symbols called Schematic Symbols are commonly used within circuit diagrams, schematics and computer aided drawing packages to identify the position of individual components and elements within a circuit.

The basic electrical and electronic graphical symbols presented here are the more generally accepted graphical symbols because of their common usage across a range of electrical and electronic fields. The individual graphical symbols below are given along with a brief description and explanation.

Table 2. 1: Power Supply Schematic Symbols

Schematic Symbol	Symbol Identification	Description of Symbol
	Single Cell	A single DC battery cell of 0.5V

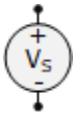
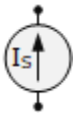
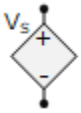
	DC Battery Supply	A collection of single cells forming a DC battery supply
	DC Voltage Source	A constant DC voltage supply of a fixed value
	DC Current Source	A constant DC current supply of a fixed value
	Controlled Voltage Source	A dependent voltage source controlled by an external voltage or current
	Controlled Current Source	A dependent current source controlled by an external voltage or current
	AC Voltage Source	A sinusoidal voltage source or generator

Table 2. 2: Electrical Grounding Schematic Symbols

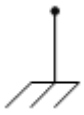
Schematic Symbol	Symbol Identification	Description of Symbol
	Earth Ground	Earth ground referencing a common zero potential point
	Chassis Ground	Chassis ground connected to the power supplies earthing pin
	Digital Ground	A common digital logic circuit ground line

Table 2. 3: Resistor Schematic Symbols

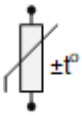
Schematic Symbol	Symbol Identification	Description of Symbol
	Fixed Resistor (IEEE Design)	A fixed value resistor whose resistive value is indicated next to its schematic symbol
	Fixed Resistor (IEC Design)	
	Potentiometer (IEEE Design)	Three terminal variable resistance whose resistive value is adjustable from zero to its maximum value
	Potentiometer (IEC Design)	
	Rheostat (IEEE Design)	Two terminal fully adjustable rheostat whose resistive value varies from zero to a maximum value
	Rheostat (IEC Design)	
	Trimmer Resistor	Small variable resistors for mounting onto PCB’s
	Thermistor (IEEE Design)	Thermal resistor whose resistive value changes with changes in surrounding temperature
	Thermistor (IEC Design)	

Table 2. 4: Capacitor Schematic Symbols

Schematic Symbol	Symbol Identification	Description of Symbol
	Fixed Value Capacitor	A fixed value parallel plate non-polarized AC capacitor whose capacitive value is indicated next to its schematic symbol
	Polarized Capacitor	A fixed value polarized DC capacitor usually an electrolytic capacitor which must be connected to the supply as indicated
	Variable Capacitor	An adjustable capacitor whose capacitance value can be varied by means of adjustable plates

Table 2. 5: Inductor and Coil Schematic Symbols

Schematic Symbol	Symbol Identification	Description of Symbol
	Open Inductor	An open inductor, coil or solenoid that generates a magnetic field around itself when energized
	Iron Core Inductor	An inductor formed by winding the coil around a solid laminated iron core indicated by solid lines
	Ferrite Core Inductor	An inductor formed by winding the coil around a non-solid ferrite core indicated by dashed lines

Table 2. 6: Switch and Contact Symbols

Schematic Symbol	Symbol Identification	Description of Symbol
	SPST Toggle Switch	Single-pole single-throw toggle switch used for making (ON) or breaking (OFF) a circuits current

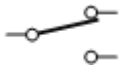
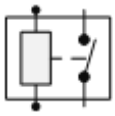
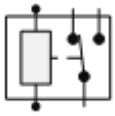
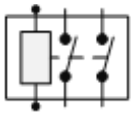
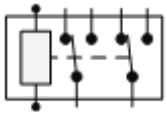
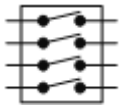
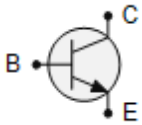
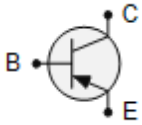
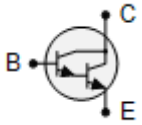
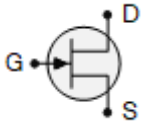
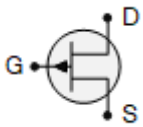
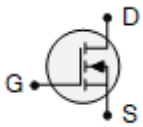
	SPDT Changeover Switch	Single-pole double-throw changeover switch used for changing the direction of current flow from one terminal to another
	Pushbutton Switch (N.O)	Normally open contacts pushbutton switch – push to close, release to open
	Pushbutton Switch (N.C)	Normally closed contacts pushbutton switch – push to open, release to close
	SPST Relay Contacts	Electromechanical relay with internal single-pole single-throw toggle contacts
	SPDT Relay Contacts	Electromechanical relay with internal single-pole double-throw changeover contacts
	DPST Relay Contacts	Electromechanical relay with internal double-pole single-throw toggle contacts
	DPDT Relay Contacts	Electromechanical relay with internal double-pole double-throw changeover contacts
	DIP Switch Assembly	PCB mounted DIP switch with 1-to-10 toggle switches either single-pole, double-pole, rotary or with a common terminal

Table 2. 7: Semiconductor Diode Symbols

Schematic Symbol	Symbol Identification	Description of Symbol
	Semiconductor Diode	Semiconductor PN-junction diode used for rectification and high current applications

	Zener Diode	Zener diode used in its reverse voltage breakdown region for voltage limiting and regulation applications
	Schottky Diode	Schottky diode consisting of an n-type semiconductor and metal electrode junction for low voltage applications

Table 2. 8: Transistor Symbols

Schematic Symbol	Symbol Identification	Description of Symbol
	NPN Bipolar Transistor	Characterized as being a lightly doped p-type base region between two n-type emitter and collector regions with the arrow indicating direction of conventional current flow out.
	PNP Bipolar Transistor	Characterized as being a lightly doped n-type base region between two p-type emitter and collector regions. Arrow indicates direction of conventional current flow in.
	Darlington Pair Transistor	Two bipolar transistor NPN or PNP connected in a series common collector configuration to increase current gain
	N-JFET Transistor	N-channel junction field effect transistor having an n-type semiconductive channel between source and drain with the arrow indicating direction of conventional current flow
	P-JFET Transistor	P-channel junction field effect transistor having a p-type semiconductive channel between source and drain with the arrow indicating direction of conventional current flow
	N-MOSFET Transistor	N-channel metal-oxide semiconductor field effect transistor with an insulated gate terminal which can be operated in depletion or enhancement mode

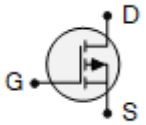
	P-MOSFET Transistor	P-channel metal-oxide semiconductor field effect transistor with an insulated gate terminal which can be operated in depletion or enhancement mode

Table 2. 9: Photodevice Schematic Symbols

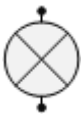
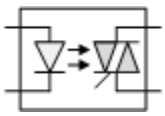
Schematic Symbol	Symbol Identification	Description of Symbol
	Light Emitting Diode (LED)	A semiconductor diode which emits colored light from its junction when forward biased
	7-segment Display	A 7-segment display used common cathode (CC) or common anode (CA) for displaying single numbers and letters
	Photodiode	A semiconductor device which allows current to flow when exposed to incident light energy
	Solar Cell	P–N junction photovoltaic cell transducer which converts light intensity directly into electrical energy
	Photoresistor	Light dependent resistor (LDR) which changes its resistive value with changes in light intensity
	Indicator Lamp or Light Bulb	A filament lamp, indicator or other which emits visible light when a current flows through it
	Opto-isolator or Optocoupler	An Opto-isolator or Optocoupler which uses photo-sensitive devices to isolate its input and output connections

Table 2. 10: Digital Logic Symbols

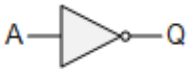
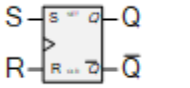
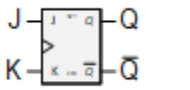
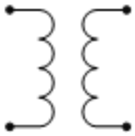
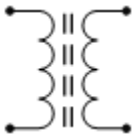
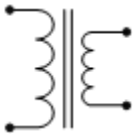
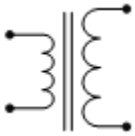
Schematic Symbol	Symbol Identification	Description of Symbol
	NOT Gate	Logic gate with only one input and one output and outputs a logic 1 (HIGH) when input is 0 (LOW) and outputs a 0 when input is 1 (Inverter)
	AND Gate	Logic gate with two or more inputs which outputs a logic 1 (HIGH) when ALL of its inputs are at logic 1 (HIGH)
	NAND Gate	Logic gate with two or more inputs that outputs a logic 0 (LOW) when ALL of its inputs are HIGH at logic 1 (Equivalent to NOT + AND)
	OR Gate	Logic gate with two or more inputs which outputs a logic 1 (HIGH) when ANY (or both) of its inputs are at logic 1 (HIGH)
	NOR Gate	Logic gate with two or more inputs that outputs a logic 0 (LOW) when ANY (or both) of its inputs are HIGH at logic 1 (Equivalent to NOT + OR)
	XOR Gate	Exclusive-OR gate with two inputs that outputs a logic 1 (HIGH) whenever its two inputs are DIFFERENT
	XNOR Gate	Exclusive-NOR gate with two inputs that outputs a logic 1 (HIGH) whenever its two inputs are the SAME (NOT + XOR)
	SR Flip-Flop	Set-Reset Flip-flop is a bistable device used to store one bit of data on its two complementary outputs
	JK Flip-Flop	JK (Jack Kilby) Flip-flop has the letter J for Set and the letter K for Reset (Clear) with internal feedback

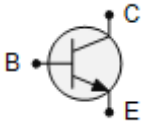
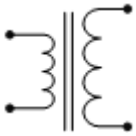
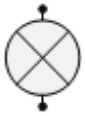
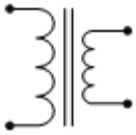
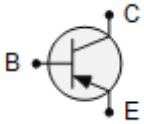
Table 2. 11: Schematic Transformer Symbols

Schematic Symbol	Symbol Identification	Description of Symbol
	Air-core Transformer	Single-phase air-core voltage transformer with two inductive coils wrapped closely together around a solid or hollow plastic non-magnetic core for radio frequency applications
	Iron-core Transformer	Single-phase iron-core voltage transformer (VT) formed by winding the two coils around a solid laminated iron core, indicated by the symbols two solid lines, for the transfer of electrical energy from one winding to the other changing an AC voltage from high to low or low to high
	Power Transformer	Single-phase power transformer (PT) shown as two interconnecting circles for the transmission and distribution of electrical power from high to low or low to high
	Ferrite-core Transformer	Single-phase transformer formed by winding the two coils around a non-solid compressed ferrite core to decrease eddy current losses, hum and increase the magnetizing flux. Used mainly in toroidal transformers
	Step-down Transformer	Single-phase step-down isolation transformer which converts a higher primary winding voltage into a lower secondary winding voltage by an amount determined by the turn's ratios of the transformer
	Step-up Transformer	Single-phase step-up transformer which converts a lower primary winding voltage into a higher secondary winding voltage by an amount determined by the turns ratios of the transformer

Self-check-2.1

Part I: Matching

Direction: match column A with column B. writes your answer on the space provided before the number.

Column A	Column B
_____ 1. Indicator lamp	A. 
_____ 2. Step up transformer	B. 
_____ 3. Capacitor	C. 
_____ 4. Step down transformer	D. 
_____ 5. AND Gate	E. 
_____ 6. NPN transistor	F. 
_____ 7. PNP transistor	G. 
_____ 8. Pushbutton	H. 

Part II: Identification

Direction: From the given alternatives write the correct answer on the space provided for each of the following questions.

Single line diagram **Electrical schematic** **Logic diagram**

CAD **Ladder diagram**

1. _____ a logical representation of the physical connections and layout of an electric circuit.

2. _____ are used for determining and isolating any faulty equipment in any power system during troubleshooting.
3. _____ are electrical diagrams that represents an electrical circuit in industries to document control logic systems.
4. _____ are commonly used in digital circuit designing

Part III: Enumeration

Direction: write or list down the following.

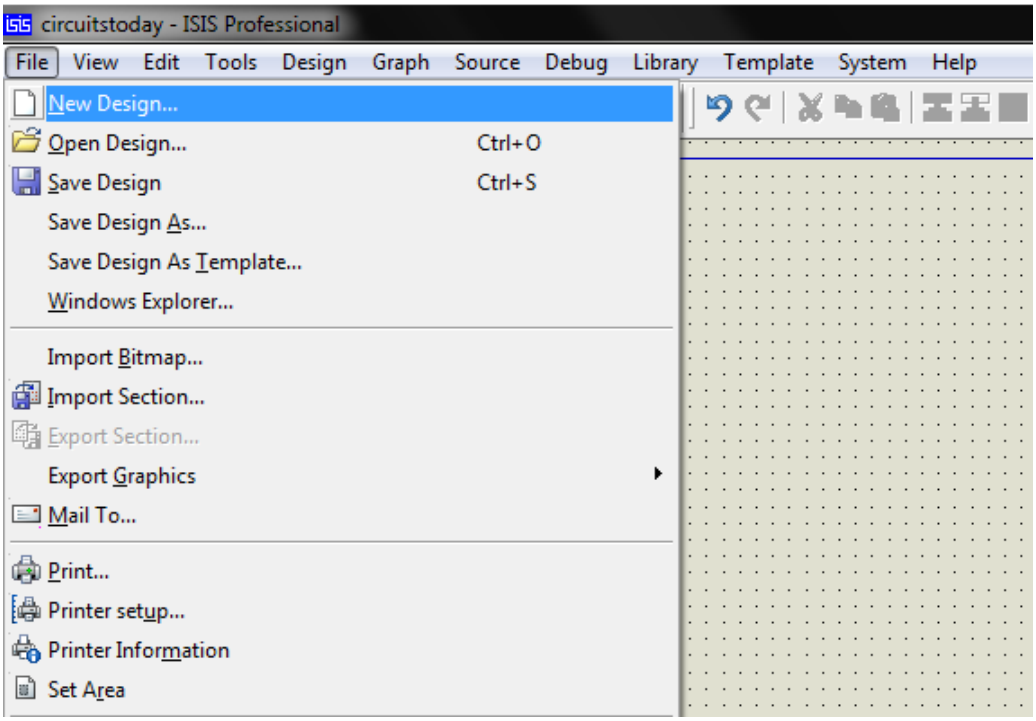
1. Results of poor documentation
   a) _____
   b) _____
   c) _____
   d) _____
2. Categories of documentation
   a) _____
   b) _____
   c) _____
   d) _____
3. Types of Electrical Diagrams and Drawings
   a) _____
   b) _____
   c) _____
   d) _____
   e) _____

Operation sheet 2.1: Opening new program

- **Operation title: Starting new Proteus design**
- **Purpose:** To be familiar with Proteus software
- **Instruction:** follow the steps to design new circuit on Proteus software. You have given 1 hour for the task.
- **Tools and equipment:**
  - Desktop Computer
  - Proteus software

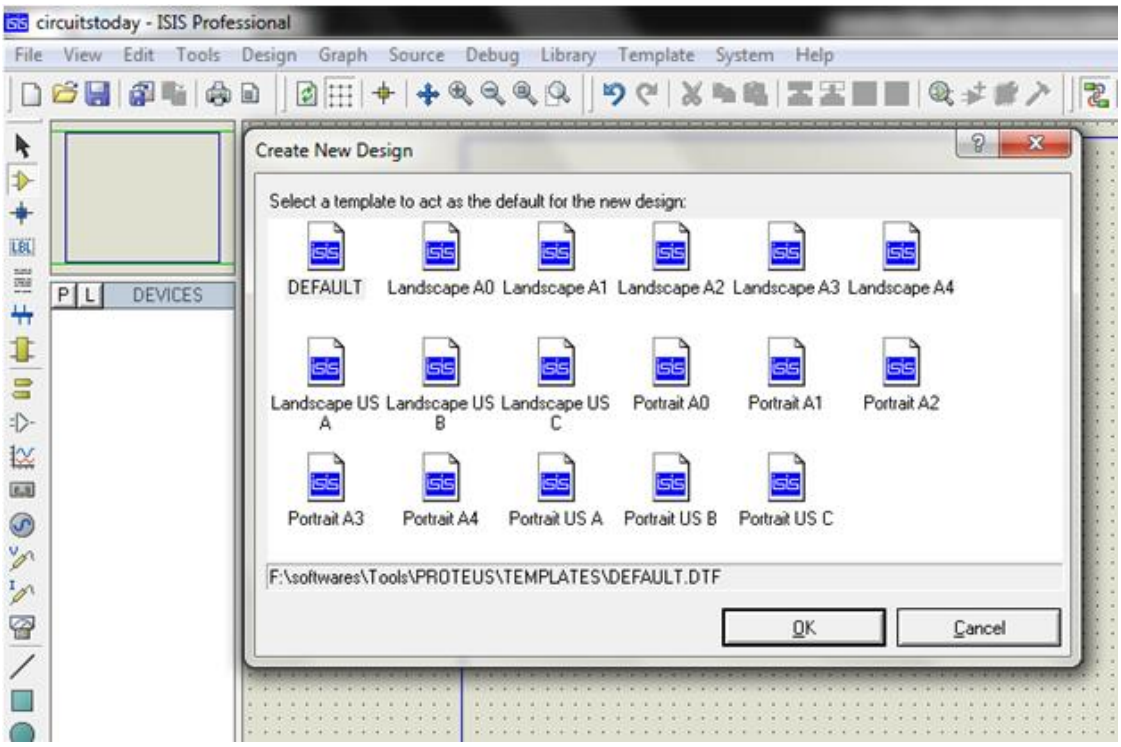
- **Steps in doing the task**

Step 1: Open ISIS software and select new design in File menu



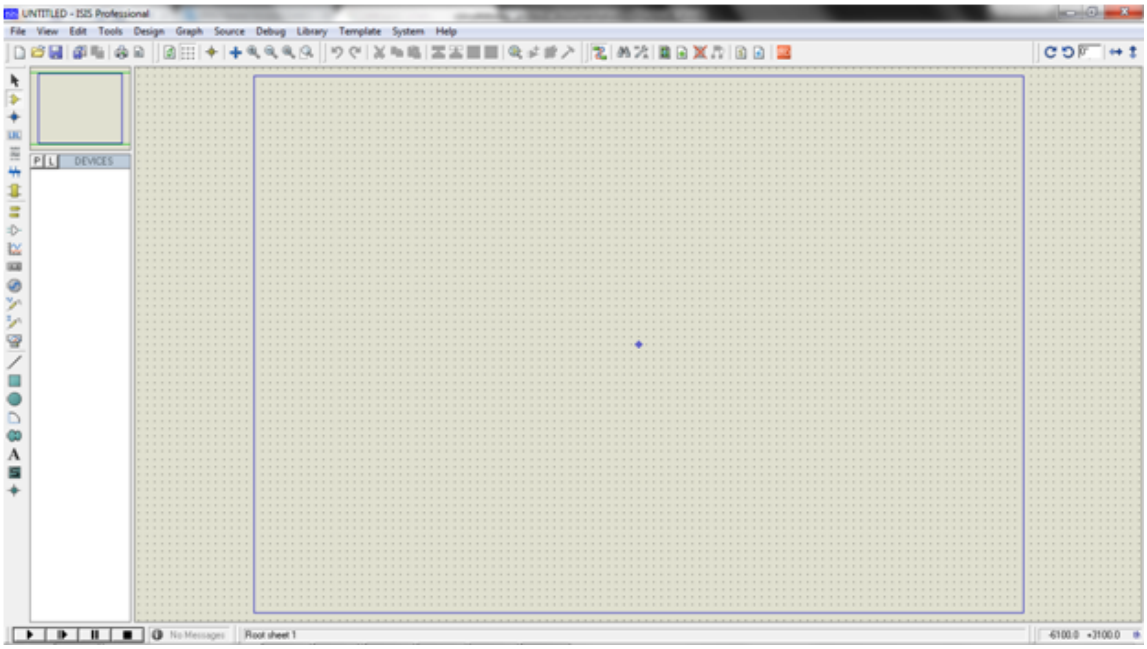
Proteus File Menu

Step 2: A dialogue box appears to save the current design. However, we are creating a new design file so you can click Yes or No depending on the content of the present file. Then a Pop-Up appears asking to select the template. It is similar to selecting the paper size while printing. For now, select default or according to the layout size of the circuit.



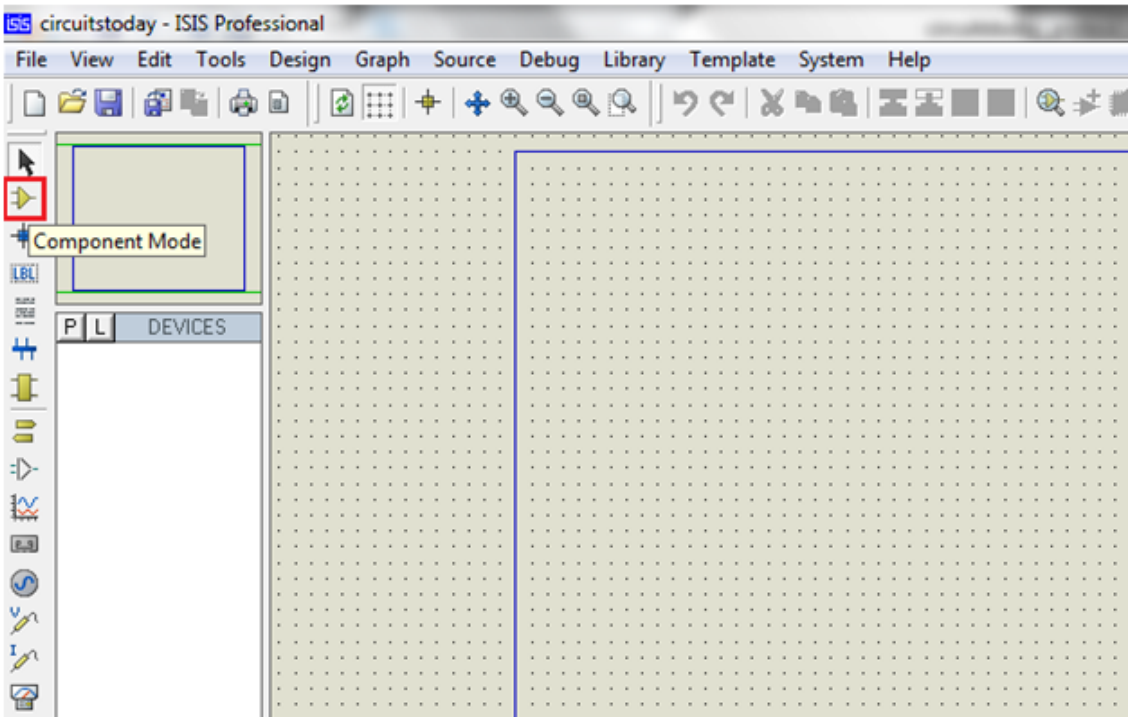
Proteus Default Template Select

Step 3: An untitled design sheet will be opened, save it according to your wish, it is better to create a new folder for every layout as it generates other files supporting your design. However, it is not mandatory.



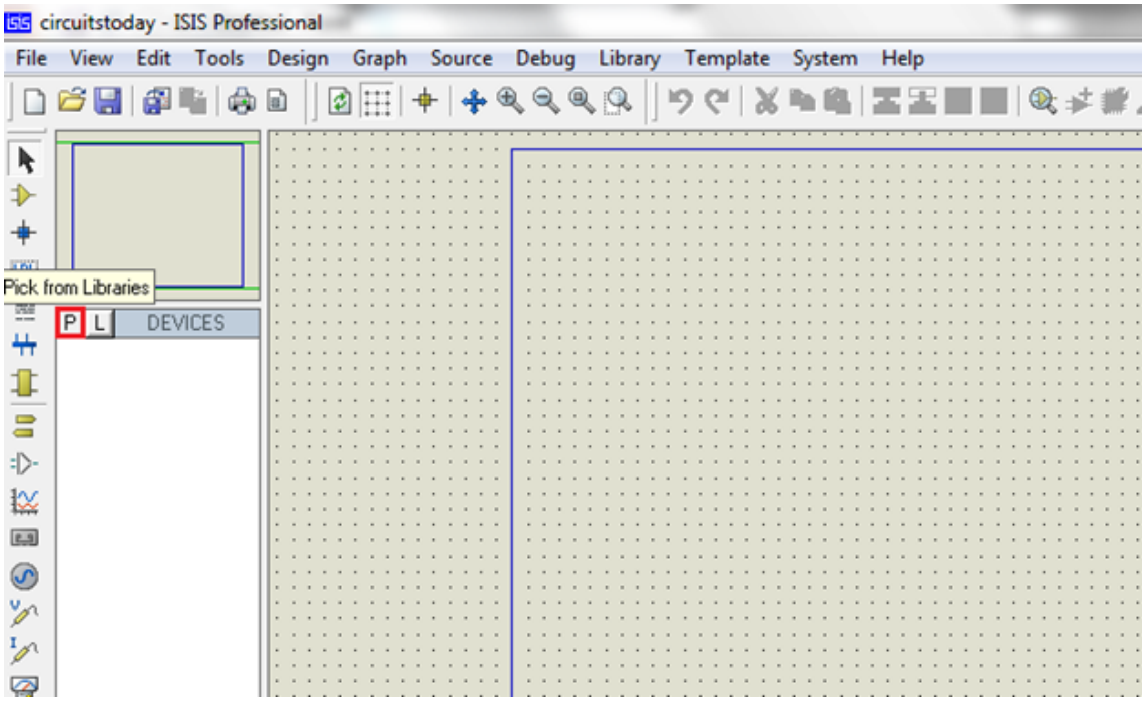
Proteus Design Sheet

Step 4: To Select components, Click on the component mode button.



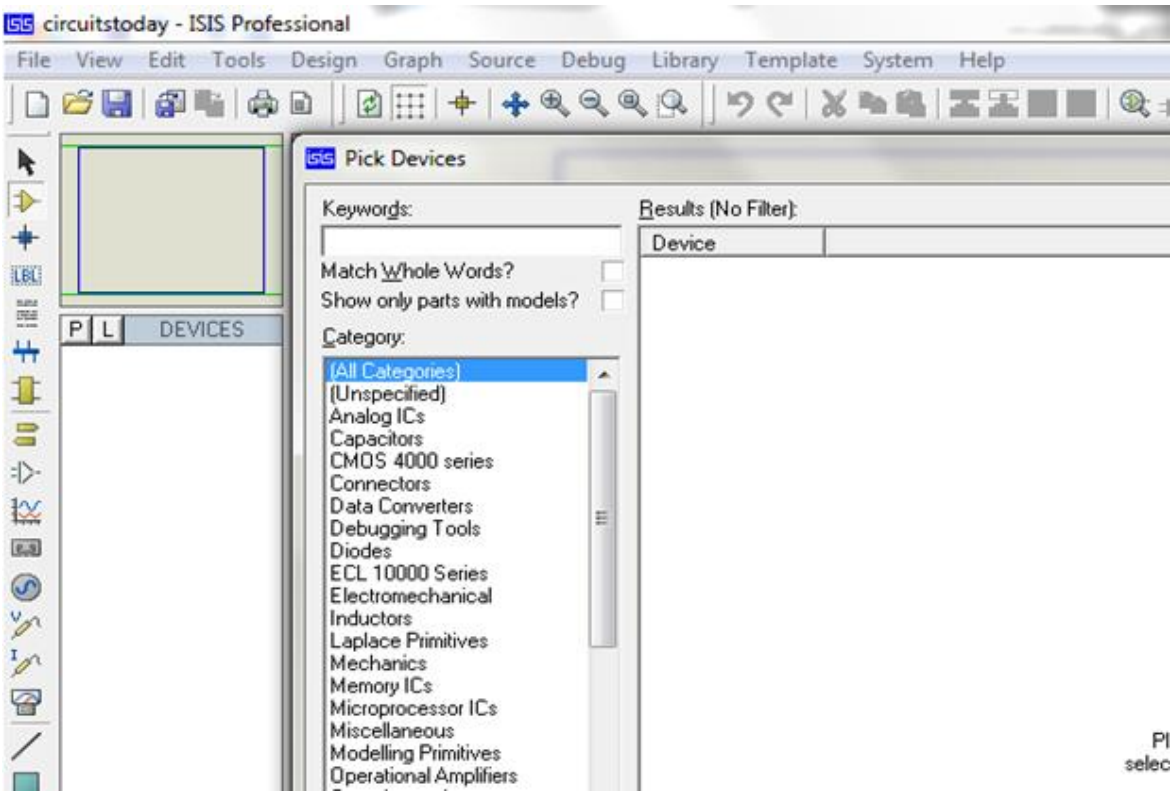
Component Mode

Step 5: Click on Pick from Libraries. It shows the categories of components available and a search option to enter the part name.



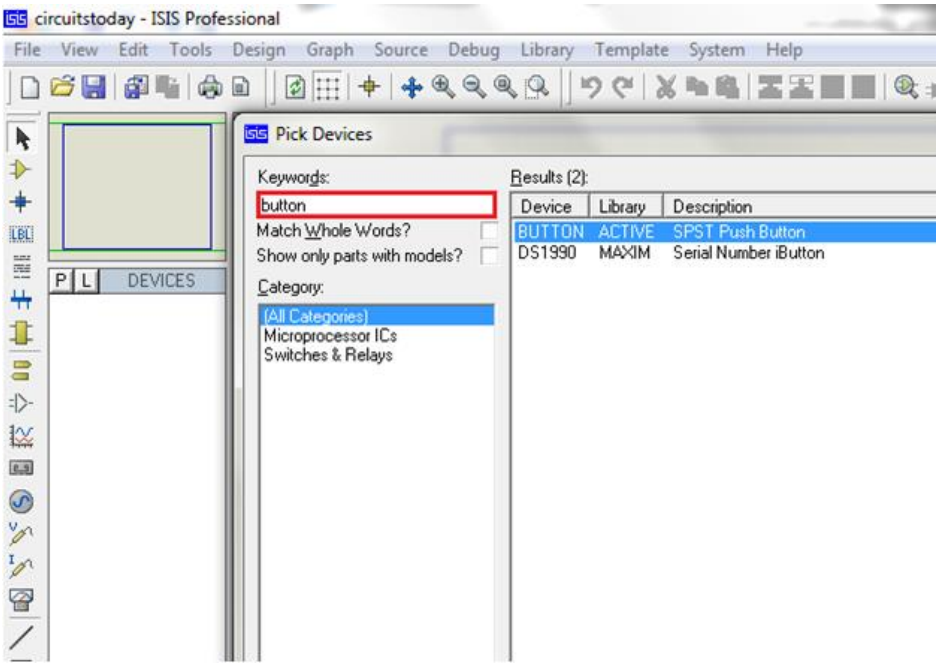
Pick from Libraries

Step 6: Select the components from categories or type the part name in Keywords text box.



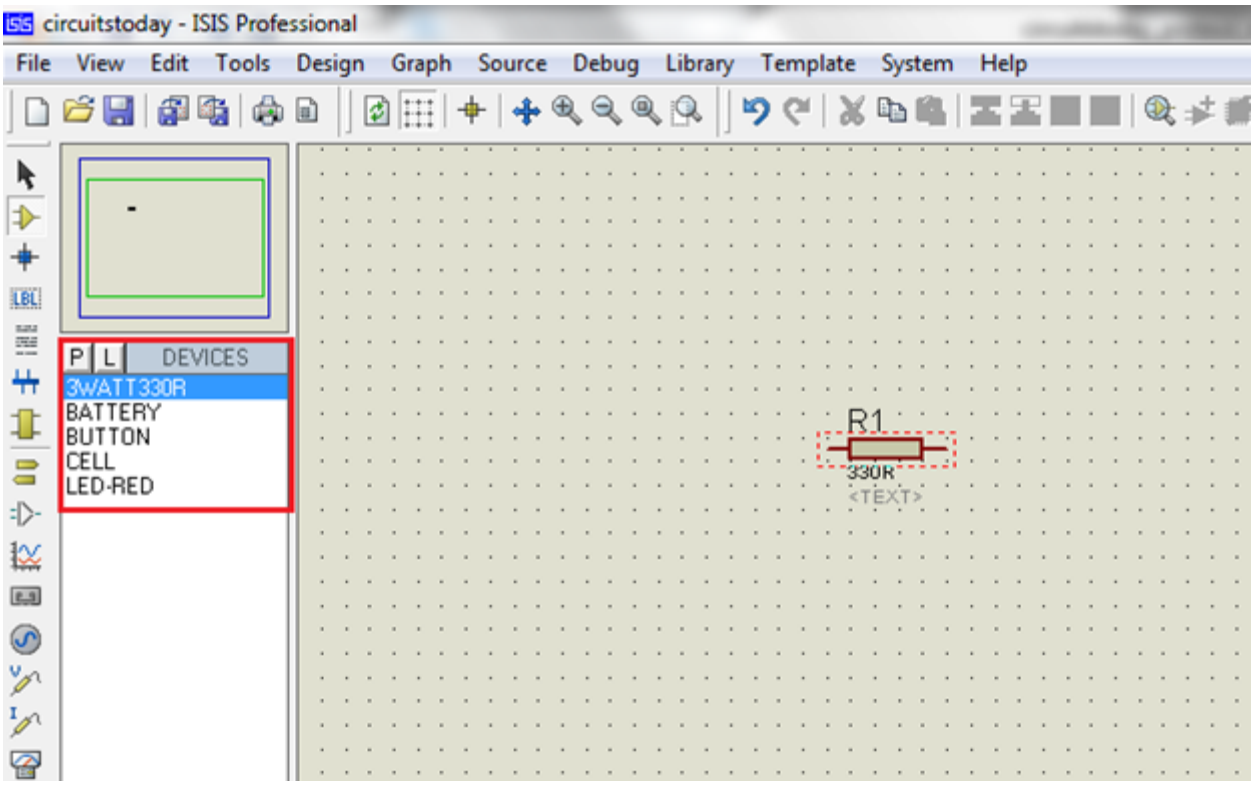
Keywords Textbox

Example shows selection of push button. Select the components accordingly.



Push Button Selection

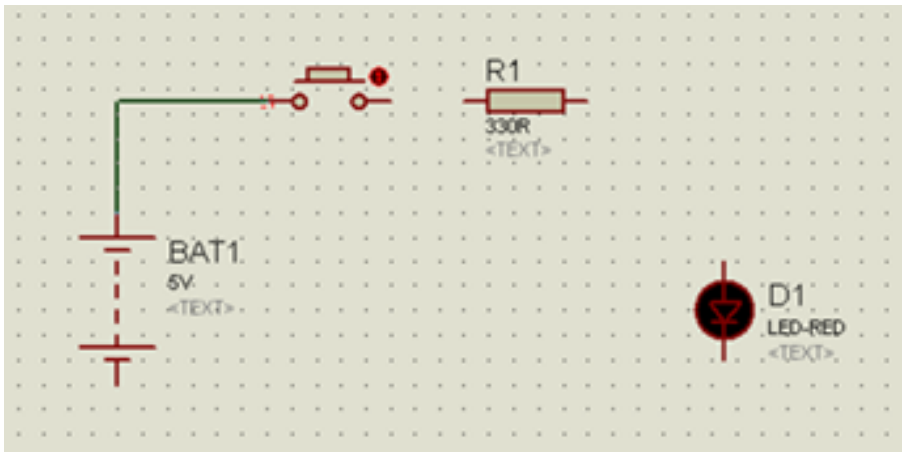
Step 7: The selected components will appear in the devices list. Select the component and place it in the design sheet by left-click.



Component Selection

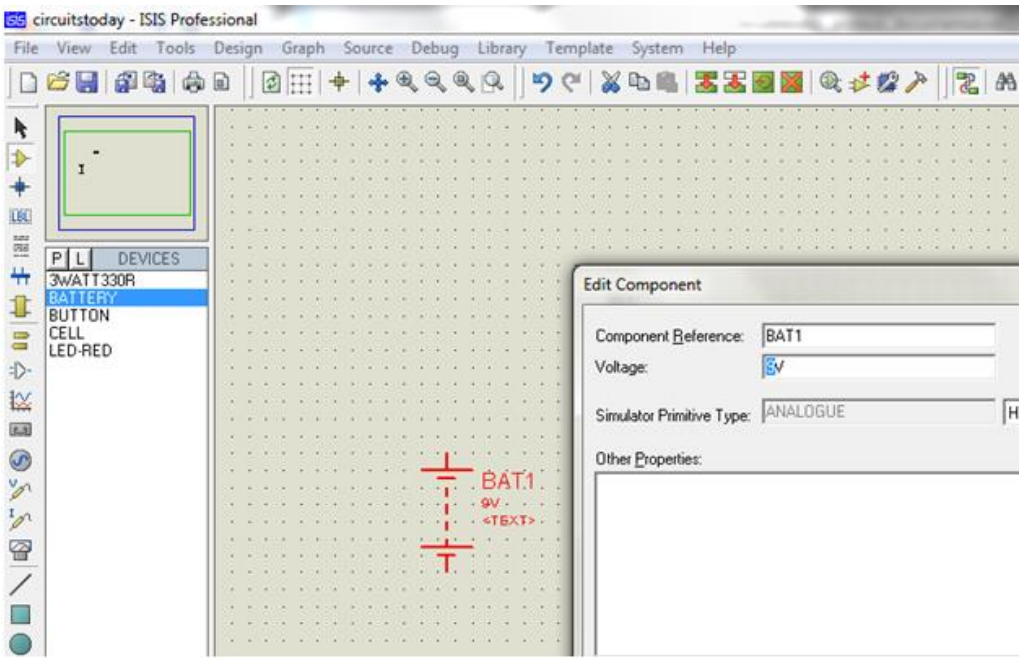
Place all the required components and route the wires i.e., make connections.

Either selection mode above the component mode or component mode allows to connect through wires. Left click from one terminal to other to make connection. Double right-click on the connected wire or the component to remove connection or the component respectively.



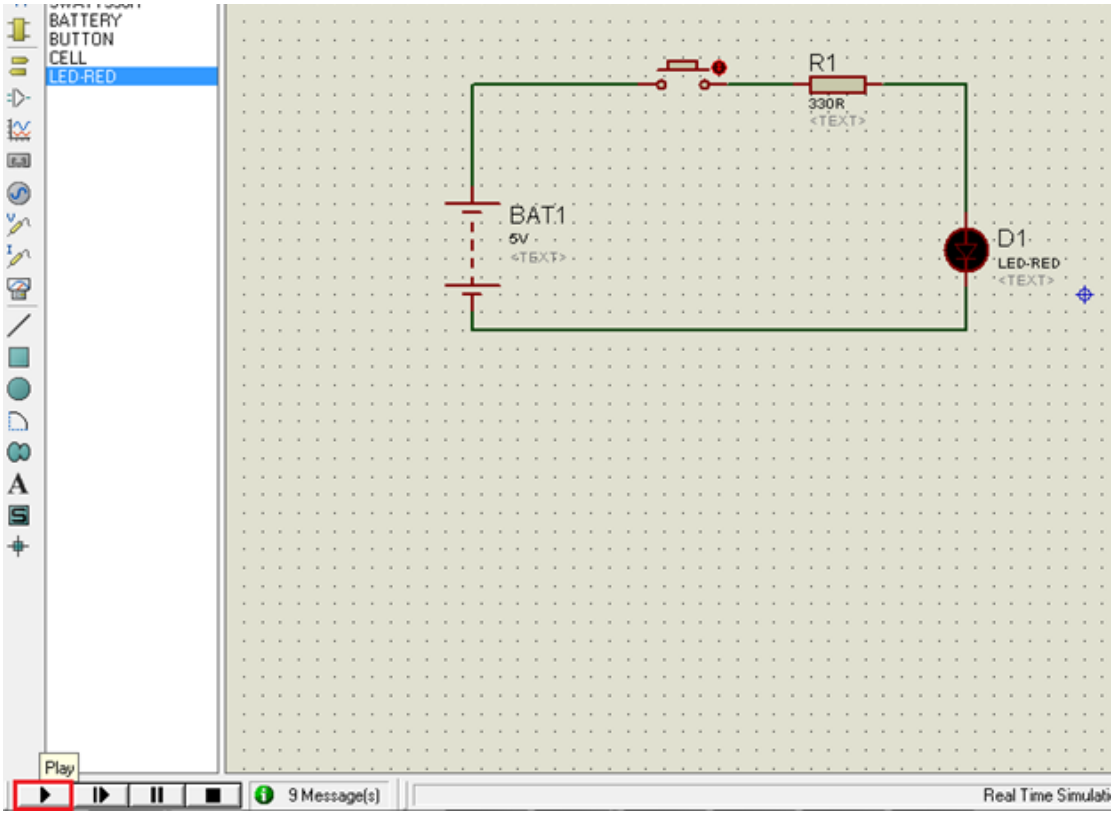
Component Properties Selection

Double click on the component to edit the properties of the components and click on Ok.



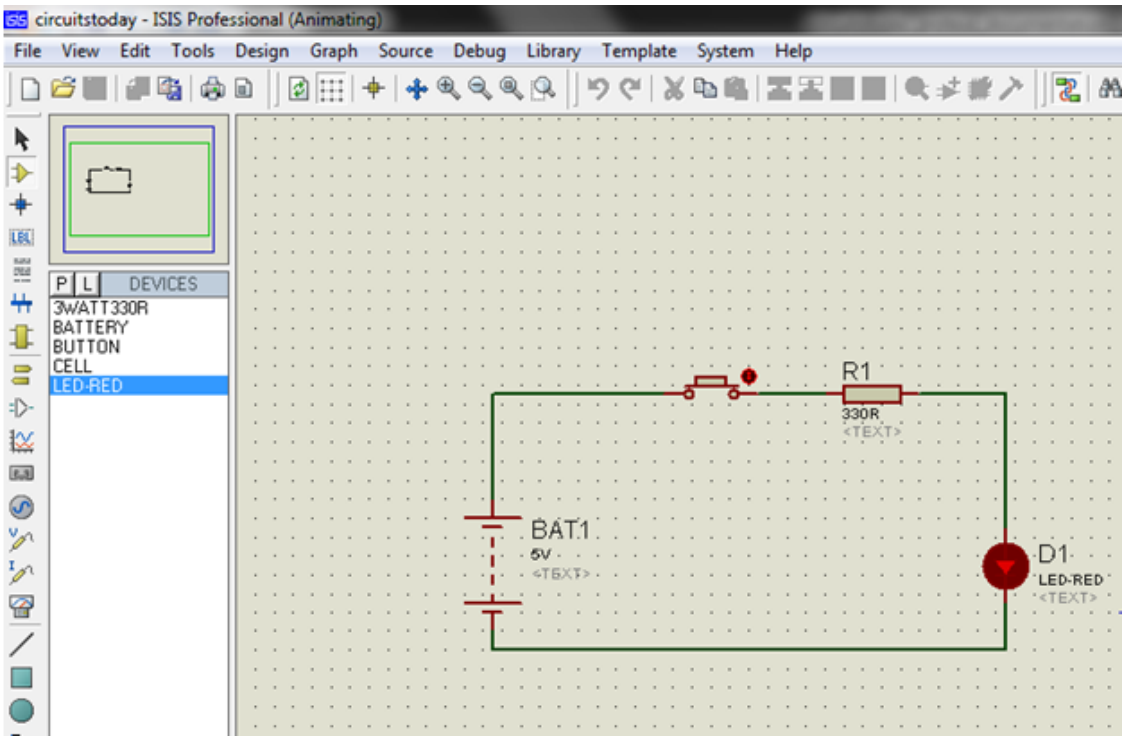
Component Properties Edit

Step 8: After connecting the circuit, click on the play button to run the simulation.



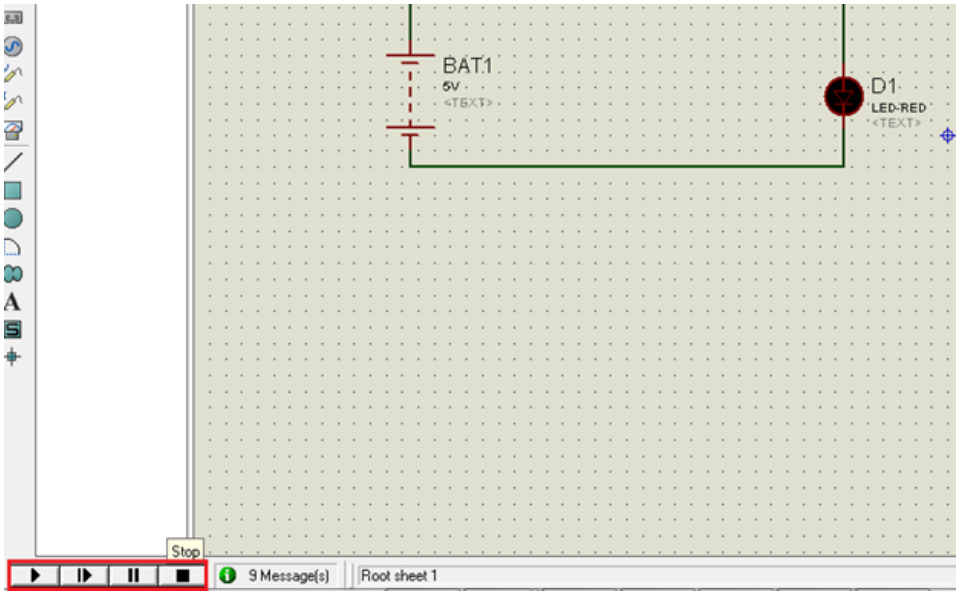
Simulation Run

In this example simulation, the button is depressed during simulation by clicking on it to make LED glow.



Simulation Animating

Simulation can be stepped, paused or stopped at any time.



Simulation Step-Pause-Stop Buttons

Lap Test-1

- Task-1: Design a 5V DC power supply using Proteus software.
- Task-2: Draw the control and power circuit for DOL, Star-Delta using Visio Software.
- Task-3: Draw the layout diagram of two-way switch control using E-CAD software
- Task-4: Draw the layout diagram of two-way switch control using Visio software
- Task-5: design and simulate two resistors when connected in series with 12VDC power supply
- Task-6: design and simulate two resistors when connected in parallel with 12VDC power supply

Unit Three: Perform finalize works

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Interpreting technical data of system components
- Checking details of drawings based on job specification
- Finalizing documents by using technical functions
- Responding unplanned situations

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Interpret technical data of system components
- Check detailed drawings based on job specification
- Finalize documents by using technical functions
- Respond to unplanned situations according to work place procedure

3.1. Interpreting technical data of system components

Designing, installing, and troubleshooting of electrical systems requires the use of various drawings to give engineers, installers, and technicians a visual representation of the systems they work with. Electrical equipment and circuitry are often expressed as symbols and lines that represent the various components and connections within a system. The level of complexity within an electrical drawing will vary depending on the intended purpose and personnel working with the drawing.

Design engineers and technicians use schematics to build and troubleshoot complex circuits, while plant operators use single-line and riser diagrams to facilitate switching operations within their distribution system. Knowing how to read and interpret various types of electrical drawings are an essential skill that all electrical workers must possess to effectively carry out their tasks. The symbols and lines within an electrical drawing speak a language that everyone involved must understand in order to design, build, and troubleshoot electrical systems

Design documentation is prepared to a level that allows the works to be constructed accurately. The design documentation includes design drawings, bill of quantities and technical specifications. Design drawings are developed to a level of detail necessary to prepare a clear, coordinated visual depiction of all aspects of the works.

Technical specifications are prepared to provide consistency and to instruct workers/technicians on how the works are to be carried out, the quality of the workmanship and methods of quality assurance for the construction of the circuit/project. Technical specifications describe the project design and construction practices, technical standards, specifications and principles to be followed during construction.

Technical specifications may specify a performance goal (a performance specification) or procedures used to meet the performance goal (design specification).

The objectives of the design drawings and technical specifications are to:

- ✓ Provide a detailed record of the design of the project
- ✓ Set standards for the technical aspects required in the construction
- ✓ Set standards for the execution of the construction
- ✓ Set standards for documenting the design, tendering and construction process

Electrical specifications generally are qualitative, with exact quantities, ratings, and dimensions covered in the drawings and schedules or on data sheets. If the specifications conflict with the drawings, the written specifications take precedence over the drawings.

Data sheets are brief descriptions of specific ratings and requirements for equipment or material. They are generally used in conjunction with a written specification to convey detailed information about a particular piece of equipment when a general section species multiple similar items. Data sheets reduce the need to edit a master specification and can be generated automatically from a database.

3.2. Checking detailed drawings based on job specification

It is extremely important to create all drawings with 100% accuracy. This cannot be stressed strongly enough as it is essential that each object in the drawing is positioned and sized perfectly. Most lab exercises in the CAD book can be checked for accuracy by overlaying the drawing with a key. This helps you to know when your drawing is accurate and will display any objects that are drawn incorrectly. As you become more experienced drawing in CAD, you will not require the use of keys. Interface varies slightly for each release.

Completing and checking drawings

Before presenting the drawings as complete you need to check all criteria against the documentation and specifications that were established at the start of the project. This is the case for both manual and CAD drawings. For example, when the draft is complete, it is essential to make sure that all angles, shapes and dimensions are checked against the specifications and any sample object you may have.

Once the drawings have been checked against the documentation and specifications, adjustments or changes can only be made after consultation and with authority from the project supervisor or the factory manager. A final draft can then be produced. Completed drawings also need to be checked to make sure they comply with workplace documentation requirements. These may vary from place to place but will include checking that drawings are completed to the correct scale and to the accepted tolerances. For example:

- ✓ Lines should be perpendicular to the base or ground line
- ✓ Lines should have evenly proportioned spaces separating the views both vertically and horizontally, and

- ✓ All dimensions must be drawn to plus or minus one millimeter.

Checklist for checking drawings

Dimensions	Has the height, width and depth been correctly interpreted?
Angles	Have all angles been drawn precisely as indicated?
Shape	Is there any variation from the specifications? If there have been changes, have they been documented?
Line work	Has all final lining in been done accurately?
Titles	Are the entries in the title box appropriate?

3.3. Finalizing documents using technical function and formatting

Document formatting refers to the way a document is laid out on the page—the way it looks and is visually organized—and it addresses things like font selection, font size and presentation (like bold or italics), spacing, margins, alignment, columns, indentation, and lists. Basically, the mechanics of how the words appear on the page. A well formatting document is consistent, correct (in terms of meeting any stated requirements), and easy to read.

The visual appeal of a document has an effect on the reader and how they perceive the information, so it's important in any piece of writing or documentation to be concerned with its formatting. Formatting also makes information more accessible to the reader by creating and labeling sections (headings), highlighting key words or ideas (bold, italics, or lists), and making a good impression (professional look and feel, appropriate font choice for the document type).

There are many ways to format a technical or professional document. Assignments may specify formatting requirements, but if a style is not dictated, maintain a clear and consistent format throughout the document. Especially when combining work from multiple team members, details like slight differences in font size or line spacing are easy to miss, but these subtle inconsistencies detract from the overall professionalism of your document. Sloppy formatting will reflect poorly on your abilities, and your audience may lose confidence in your message.

Basic Formatting Standards for Lab Documents

A few standards that should be used in most lab documents, unless specified otherwise:

- ✓ 11-12 pt. font in a consistent style throughout, including headers, footers, and visual labels
- ✓ 14 pt font for section headings (and "Memo" or other document label within a header)
- ✓ A standard, professional font (e.g., Times New Roman, Cambria, Calibri)
- ✓ Single or 0.15 line spacing, with no indentation on the first line of the paragraph
- ✓ Additional line break between paragraphs
- ✓ Left-justified body text
- ✓ Page numbers at bottom right corner (starting the first page of the main text, i.e. not the cover page or Table of Contents)
- ✓ 1in. margins

3.4. Responding to unplanned situation

Exception handling is the method of building a system to detect and recover from exceptional conditions. Exceptional conditions are any unexpected occurrences that are not accounted for in a system's normal operation. It is difficult to protect a system from the effects of exceptional conditions because, by nature, all unusual occurrences cannot be anticipated when the system is designed. Some examples of exceptional conditions are incorrect inputs from the user, bit level memory or data corruption, software design defects that cause a system to enter an undefined state, and environmental anomalies. If these exceptional conditions are not properly caught and handled, they can cause an error or failure in the system. Tips in handling computer problems that makes it to run slowly.

1. ***Free up RAM by closing other open programs.***

Every piece of software uses Random Access Memory (RAM). The more software that's running on your computer, the more RAM it uses. This can be especially problematic if you're using older machines that don't have a lot of RAM. So, if a software program refuses to load or is running slowly, the first thing to do is to close all other open applications.

2. ***Restart the software.***

Software problems can stem from a conflict with other programs or simply from difficulties the software encountered when starting up. Shutting the program down and restarting it can sometimes resolve these issues.

3. ***Shut down and restart your computer.***

If restarting the problematic program doesn't resolve the issue, try rebooting your computer. Once the computer has fully restarted, re-launch the application in question and see if the problem has been resolved.

4. ***Use the Internet to find help.***

No matter what software problems you encounter, chances are it's happened to someone else. So, there's a good chance you can find help on the Internet.

5. ***Undo any recent hardware or software changes.***

Changes to software and hardware can sometimes cause software problems, such as:

Conflicts with other software: Newly installed software may conflict with other software.

Changes to computer settings*:* Undo any recent changes to your computer's settings, and try launching the software again. For example, the Windows Control Panel includes an option to "Set Program Access and Defaults," which allows you to disable access to certain applications. If you accidentally disable access to a program here, the program may not run.

Conflicts with new or improperly configured hardware, such as scanners and printers. If you've recently connected new hardware to one of your computers, try disconnecting the hardware and see if that corrects the software issue.

6. ***Uninstall the software, then reinstall it.***

Sometimes, software problems occur because critical application files have been removed, updated, or deleted. For example, many Windows applications use Dynamic Link Library (DLL) files to perform basic tasks. Often, several applications will use the same DLL file. If you've recently removed one program from your computer, it's possible you removed DLL files that another program relied on. Similarly, adding a program could add or update DLL files. Applications that were dependent on those DLL files may become unstable or stop working entirely.

7. ***Look for software patches.***

Software vendors may also fix bugs by issuing patches — small software updates that address known problems. Even if you're using the most current version of the software, there may be a more recent patch available for that version.

8. Scan for viruses and malware.

Viruses, spyware, and other forms of malicious software (or "malware") can cause software to freeze, crash, or quit working entirely. If tips 1 through 8 haven't helped solve your software problem, you may also want to scan the computer using both antivirus and anti-malware tools to find and remove viruses and malware. Use the most thorough scan mode available, and remember to restart your machine if the antivirus or anti-malware programs found any threats.

9. Check for a firewall conflict.

Some organizations may choose to install personal firewall software on each computer, rather than a centralized hardware or software-based firewall. Personal firewalls can be an important line of defense against hackers and other security threats, but they can also cause software conflicts.

Firewalls frequently display messages asking whether it should allow a program to run or block it. Therefore, it's possible to accidentally tell the personal firewall to block a program from running. Check the firewall's settings to see if the problematic software was added to the firewall's list of programs to block. If so, change the firewall's settings to allow the software to run, then check to see if you're still having issues with your software.

10. Boot up in Safe Mode.

Some software malfunctions can be caused by OS settings or other system problems. Windows and Mac operating systems both offer a troubleshooting environment known as Safe Mode. Safe Mode disables non-critical applications and processes, which theoretically makes it easier to isolate problems.

Once your computer is in Safe Mode, launch the problematic software and try to replicate the problem you had while your computer was in normal mode. If you don't have the same problem in safe mode, there's a good chance that the issue was caused by your OS or another program, not by the application you are troubleshooting.

11. Defragment your hard drive.

As a final troubleshooting step, you might defragment your computer's hard drive. Defragmenting rearranges your hard drive's file structure so that the system runs more efficiently. Defragmenting will probably be most useful if you're experiencing overall sluggishness on your computer, because defragmenting is meant to make your entire system run faster. Note that defragmenting a hard drive applies primarily to Windows-based computers.

Self-check-3.1

Part I: True or False

Direction: Write **True** if the statement is correct and write **False** if the statement is wrong. Write your answer on the space provided before the number.

_____ 1. Viruses, spyware, and other forms of malicious software (or "malware") can cause software to perform/operate smoothly.

_____ 2. Design documentation is prepared to a level that allows the works to be constructed accurately.

_____ 3. Exception handling is the method of building a system to detect and recover from exceptional conditions.

_____ 4. The level of complexity within an electrical drawing will not vary depending on the intended purpose and personnel working with the drawing.

_____ 5. Data sheets are brief descriptions of specific ratings and requirements for equipment or material.

Part II: Identification

Direction: From the given alternatives write the correct answer on the space provided for each of the following questions.

Datasheet **Exceptional conditions** **Technical specification**

Electrical specification **Design documentation**

1. _____ are any unexpected occurrences that are not accounted for in a system's normal operation.
2. _____ are qualitative, with exact quantities, ratings, and dimensions covered in the drawings and schedules or on data sheets.
3. _____ are prepared to provide consistency and to instruct workers/technicians on how the works are to be carried out.

Part III: Enumeration

Direction: write or list down the following.

1. The objectives of the design drawings and technical specifications are
   a) _____
   b) _____
   c) _____
   d) _____
2. Basic Formatting Standards for Lab Documents
   a) _____
   b) _____
   c) _____
   d) _____

Reference

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