# Electronics

# BASIC ELECTRONICS

## INTRODUCTION

The applied science of electronics has advanced at a great rate particularly since the development of semiconductors from the late 1940's. Electronic circuits can be found in so many applications including the control circuits of power equipment. It is essential that Engineers and Technicians understand basic electronic principles and circuit theory. It is also important to understand how electronic theory is used in practice in the most common applications

## WHO SHOULD ATTEND

Engineers or Technicians who need to understand the basic principles of Electronics and its applications in the present world.

## COURSE DURATION: TEN DAYS

## SEMINAR OBJECTIVES

On completion of the course the trainee/s will be able to :

- Understand Basic Electronic Principles.
- Understand the role of various components in Electronic Circuits
- Identify and describe different electronic circuits.
- Understand the application of electronic circuits.
- Describe the basic skills and techniques required for building and fault finding on a range of common electronic circuits.

## TRAINING METHODOLOGY

The latest educational methods and strategies are employed. The course is designed to maximise delegate participation. From the outset, the goals of each participant are discussed to ensure needs are fulfilled as far as possible. Questions and Answers are encouraged throughout and at the daily wrap-up sessions. This gives participants the opportunity to discuss with other delegates and the presenter their specific problems and appropriate solutions. All delegates take away a manual of all the material presented. Only minimum note taking is encouraged to ensure maximum delegate attention during the seminars.

## Course Overview

Basic Electrical Theory
Use of Test Equipment
Electronic Construction Techniques
Identification of Component Values
Testing of Components
**Worked Examples and Exercises**

### The Diode

History – Early Arc Research
The Thermionic Valve
Resistivity, Conductors, Insulators,
**Worked Examples and Exercises**

Physics of Semiconductors
P and N type materials
The Ideal Diode
The P-N Junction Diode
Forward and Reverse Bias
The Zener Region
Basic Rectifier Circuit
Silicon versus Germanium
**Worked Examples and Exercises**

### Semiconductor Diodes

Transition and Diffusion Capacitance
Reverse Recovery Time
Temperature Effects
Diode Specification Sheets
Variations in Diode Characteristic with Temperature Change
Semiconductor Diode Notation
Diode Ohmmeter Check
DC Conditions
Diode Circuits
The Load Line and Q-point
Static and Dynamic Resistance
Average AC Resistance
Equivalent Circuits
Clippers and Clamps
The Half Wave Rectifier
The Full Wave Rectifier

## Photodiode

Relative Spectral Response for Si, Ge and Se as compared to the human eye

Basic biasing arrangement and construction

Typical Set of Photodiode Characteristics
Symbol
Applications

## Photoconductive Cell

Appearance

Terminal Characteristics

Symbol

**Exercises**

## Infrared (IR) Emitting Diodes

Structure of a semiconductor
IR-emitting Diode

Radiant Flux versus DC forward Current

Radiant Intensity patterns

Construction and Symbol

### Light-Emitting Diodes (LED's)

The Process of Electroluminescence
Electrical/Optical Characteristics
Relative Intensity versus Wavelength
Forward Current versus Forward Voltage

Relative Luminous Intensity
Relative Efficiency versus Peak Current

Maximum Peak Current versus Pulse Duration

Relative Luminous Intensity versus Angular Displacement

Applications
Number Display using LED's
Computer Screens

## Liquid Crystal Displays (LCD)

Nematic Liquid Crystal with no Applied Bias

Nematic Liquid Crystal with Applied Bias

LCD & Segment Digit Display
Transmissive Field-effect. LCD with no Applied Bias

Reflective-type LCD
**Exercises**

## Solar Cells

Short-circuit Current and Open-circuit Voltage versus Light Intensity

Spectral Response of Se, Si and the Naked Eye

Characteristics
Symbol
Applications
**Exercises**

## Thermistors

Characteristics
Symbol
Applications
Temperature Control
**Exercises**

## The Semiconductor Triode "Transistor"

History - The First Transistor
Construction
    pnp and npn junctions
Forward and Reverse Bias
Amplifyng Action
Common-Base Configuration
    Reverse Saturation Current
Common-Emitter Configuration
**Exercises**

Common-Collector Configuration
Maximum Ratings
Applications
    Circuits
**Worked Examples and Exercises**

## Combinational Logic Gates

AND
NAND
OR
NOR
NOT

Construction of  simplified logic circuits

Truth tables - Boolean expressions
Sequential Logic Systems
    Combinational
    Sequential
Applications
**Worked Examples and Exercises**

## Introduction to Maintenance of Electronic Equipment

    Guidelines
    Testing

## Manuals and Information Sources

### Wrap-up Session and Course

# ELECTRONICS AND MAINTENANCE

## INTRODUCTION

The applied science of electronics has advanced at a great rate particularly since the development of semiconductors from the late 1940's. Electronic circuits can be found in so many applications including the control circuits of power equipment. It is essential that Engineers and Technicians understand basic electronic principles and circuit theory. It is also important to understand how these principles are employed in the most common practical applications. Unlike heavy machinery and Electrical Power Equipment there is little periodic requirement for maintenance of electronic equipment. However there is often a requirement for regular testing.

## WHO SHOULD ATTEND

Engineers or Technicians who need to understand the principles of Electronics, its applications in the present world, are involved in the testing of electronic equipment and need to know how to troubleshoot faults.

## SEMINAR OBJECTIVES

On completion of the course the trainee/s will be able to :

- Understand Electronic Principles.
- Understand the role of various components in Electronic Circuits
- Identify and describe different electronic circuits.
- Understand the application of electronic circuits.
- Apply the basic skills and techniques for fault finding on a range of common electronic circuits.

## TRAINING METHODOLOGY

The latest educational methods and strategies are employed. The course is designed to maximise delegate participation. From the outset, the goals of each participant are discussed to ensure needs are fulfilled as far as possible. Questions and Answers are encouraged throughout and at the daily wrap-up sessions. This gives participants the opportunity to discuss with other delegates and the presenter their specific problems and appropriate solutions. All delegates take away a manual of all the material presented. Only minimum note taking is encouraged to ensure maximum delegate attention during the seminars.

## COURSE OUTLINE:

### Basic Electrical Theory

**Worked Examples and Exercises**

### Semi-Conductors

Resistivity, Conductors, Insulators,
**Worked Examples and Exercises**

P and N type materials
- Doping effects required to create N-type and P-type semiconductor crystals
- Hole and electron flow in a doped semiconductor material.

The P-N Junction Diode
- Depletion region in a PN junction
- The Ideal Diode
- Forward and Reverse Bias
- Cathode end of a diode on its axial lead package
- Schematic symbol and alphanumeric labeling

The Zener Region
- Normal biasing mode for Electrical characteristics of a zener diode.
- Schematic symbol
- Identifying the cathode
- Effect of zener diode impedance on zener voltage.
- Power dissipation

**Worked Examples**
- Power for the series limiting resistor in a basic zener diode voltage regulator.
- Effects on zener diode current caused by circuit loading in a zener diode voltage regulator.

**Exercises**

Basic Rectifier Circuit
Silicon versus Germanium
Transition and Diffusion Capacitance
Reverse Recovery Time
Temperature Effects
Diode Specification Sheets
Variations in Diode Characteristic with Temperature Change
Semiconductor Diode Notation
Diode Ohmmeter Check
DC Conditions
Diode Circuits
The Load Line and Q-point
Static and Dynamic Resistance
Average AC Resistance
Equivalent Circuits
Clippers and Clamps
The Half Wave Rectifier
The Full Wave Rectifier

### Photodiode

Relative Spectral Response for Si, Ge and Se as compared to the human eye

Basic biasing arrangement and construction

Typical Set of Photodiode Characteristics
Symbol
Applications

### Photoconductive Cell

Appearance

Terminal Characteristics

Symbol

**Exercises**

### Infrared (IR) Emitting Diodes

Structure of a semiconductor IR-emitting Diode

Radiant Flux versus DC forward Current

Radiant Intensity patterns

Construction and Symbol

**Light-Emitting Diodes (LED's)**
The Process of Electroluminescence
Electrical/Optical Characteristics
Relative Intensity versus Wavelength
Forward Current versus Forward Voltage

Relative Luminous Intensity
Relative Efficiency versus Peak Current

Maximum Peak Current versus Pulse Duration

Relative Luminous Intensity versus Angular Displacement

Applications
- Number Display using LED's
- Computer Screens

## Tunnel, Varactor and HF diodes

Characteristics
- Negative resistance

Symbols
Applications

## Liquid Crystal Displays (LCD)

Nematic Liquid Crystal with no Applied Bias

Nematic Liquid Crystal with Applied Bias

LCD & Segment Digit Display
Transmissive Field-effect. LCD with no Applied Bias

Reflective-type LCD
**Exercises**

## Solar Cells

Short-circuit Current and Open-circuit Voltage versus Light Intensity

Spectral Response of Se, Si and the Naked Eye

Characteristics
Symbol
Applications
**Worked Examples and Exercises**

## Thermistors

Characteristics
Symbol
Applications
Temperature Control
**Exercises**

## The Semiconductor Triode

## “Transistor”

History - The First Transistor
Construction
    pnp and npn junctions
Forward and Reverse Bias
Amplifyng Action
Common-Base Configuration
    Reverse Saturation Current
Common-Emitter Configuration
**Exercises**
Common-Collector Configuration
Maximum Ratings
Applications
    Circuits

## FET, J-FET, MOSFET Transistors

**Worked Examples and Exercises**

## Thyristors

Schematic symbols for a silicon controlled rectifier (SCR), diac, triac, and unijunction transistor.

Identification of the gate, cathode, and anode electrodes.

Electrode voltage polarities required for proper operation.

Gate-cathode forward biasing triggers

Conduction allowing anode current, but not controlling it.

Forward breakdown voltage and reverse breakdown voltage.

Triacs and Diacs
Characteristics– difference from SCR
J-FET and UJT symbols
Stand-off Ratio
Negative Resistance Characteristic
**Worked Examples and Exercises**

## Combinational Logic Gates

AND
NAND
OR
NOR
NOT

Construction of  simplified logic circuits

Truth tables - Boolean expressions
Sequential Logic Systems
    Combinational
    Sequential
Applications
**Worked Examples and Exercises**

## Testing & Maintenance of General Electronic Equipment

Handling PCB's
Guidelines for Safety
Testing
Common Causes of Failure
Troubleshooting Techniques
Using standard Instruments
    Correct Calibration
The Oscilloscope
    Types
    Application and Calibration
    Analysing the Results
Spectrum Analysers
    Applications
Testing removable Components
**Case Studies and Exercises**

## Maintenance & Testing - Industrial Electronic Control Systems

Overview of Control Systems
Programmable Logic Controllers (PLC)
MOV Controls
    Motor Control
Pump and Compressor Control
Measurands
    Temperature
    Pressure
    Flow
    Voltage
    Current
    Frequency etc

Distributed Control Systems (DCS)
SCADA Systems (SCADA)
**Case Studies and Exercises**

## Maintenance & Testing of HVAC Electronic Control Systems

Single Control Units
Multi Controls Units
Causes of Failure
Repair
**Case Studies and Exercises**

## Maintenance & Testing of Rotating Machine Electronic Control Systems

Turbines/Engines
Alternators
Motors
- Starters
- Variable Speed Drives

**Case Studies and Exercises**

## Manuals and Information Sources

## Wrap-up Session and Course Evaluation

## Advanced Electronics

**Course Objectives:**

**On completion of the course the trainee/s will be competent in:**

- The knowledge and skills of Electronic Systems, fault diagnosis and solutions.
- Electronic circuit design for specific purpose and installation.

**Course Duration:** Five Days

**Who Should Attend:**

Experienced Electronics Engineers and Technicians with at least two years in electronics or electrical circuits.

**Course Contents:**

- Decibels
- Use logarithmic unit to express measured values of gain and attenuation
- Amplifiers**,** Measures and reports on the characteristics and performance of power amplifiers
- Determining the characteristics and performance of a small signal tuned amplifier
- Investigating the operating characteristics of a linear operational amplifier in a number of configurations
- Oscillators and Designing and testing of sinusoidal oscillator
- Pulse Waveforms
- Measures and characteristics of a pulse waveform
- Noise Understanding the sources of noise and the methods of reduction
- TTL,CMOS and ECL Gates
- Investigating the operation and characteristics of TTL, CMOS, and ECL Gates
- Combinational Networks: Designing and Testing combinational networks using SSI gates
- Sequential Systems
- Investigation of the operation of circuits using MSI devices
- Thyristors and High Power Devices

- Understanding the principles of operation of Thyristors and their application to control of resistive loads using phase and integral - cycle control strategies
- Controlled Rectification
- Understanding the operation of single phase rectifiers and AC controllers with resistive and inductive loads
- Unijunction and Triggering Circuits, Understanding the operation of unijuntion transistors (UJT) and it's application to thyristor triggering circuits

## Electronics Circuit Diagrams

**Course Objectives:**

**This course is designed to give the participants:**

- The basics and principles of electronic circuit diagrams
- Interpretation of the diagram and schematics
- Designing a basic circuit layout using circuit diagrams and schematics principles

**Course Duration:** Five Days

**Course Contents:**

- **The What and Why of Schematic Diagrams**

- Definition and Purpose
- Related Types of Diagrams
- Schematics and Physical Features
- Merging and crossing Connections
- Grounds

- **Component Symbols and Diagram Formation**

- Connections and Power Sources
- Batteries
- Letter Symbols
- Rotary Generator Sources
- Resistors
- Capacitors
- Inductors
- Transformers
- Switches and Relays
- The Diode
- Bipolar Transistors
- Field Effect Transistor
- Other Semi conductor Components
- Simplest Discreet Component Circuits
- Linear Modules
- Digital Logic Packets

- Integrated Circuits

- **Functional Sequence and Block Diagrams**
- Importance of Functional Sequence
- The Block Diagram
- Wiring Diagrams
- Printed Circuit Boards
- Physical layout and Location Diagrams
- Labeling and Parts List
- Exercises & Group Discussions
- Course Summary & Course Evaluation

## Who Should Attend:

Electronics Engineers or Technicians who need to understand the basics of Electronic Diagrams and Schematics.

## Basic Electrical & Electronics

**Course Objectives:**

**This course is designed to give the participants:**

- The basics and principles of electric power, electrical systems and circuits
- The basic skills and techniques required for building and fault finding on a range of common electronic circuits.
- Basic design and application of electronic circuits.

**Course Duration: Twenty Days**

**Who Should Attend:**

Potential Electronics Engineers or Technicians who need to understand the basics of Electronics and Principles.

**Course Contents:**

- Revision of Essential Mathematics applied to Electronic Engineering
- Basic Electronics Laws and Theory and the Use of Test Equipment
- Electronic Construction Techniques and Identification of Component Values and Testing of Components
- Transformers and their Characteristics
- Solid State Circuits: Design, applications and principles Electronic Switches
- Electrical Principles
- Electrical Circuits
- Power Supplies and Integrated Circuits, Power and Motor Control Circuits
- Semiconductor Diodes and Semiconductor Materials, pn junction forward and reverse characteristics, Signal, Power and Zener diodes
- Bridge Rectifier, smoothing and simple dc power unit
- Measurement of the common - emitter characteristics and plot the load - line
- Describe simple equivalent circuit for the small signal voltage amplifier

- Calculate the gain in decibels and plot the frequency response of a solid state amplifier
- Combined Logic Gates, AND, NAND, OR, NOR, and NOT gates
- DTL family of Logic gates; TTL and CMOS family of logic gates with verification of logic functions
- Techniques to minimize Boolean expressions
- Construct simplified logic circuits and verify that their truth tables are according to the Boolean expressions
- Sequential Logic Systems and Recognize the difference between combinational and sequential logic systems
- Data Carrier Media, Radio, Microwave, Fibre-Optic
- Thyristors and Power Electronics Applications
- Distributed Control Systems and SCADA
- Case studies,
- Discussions
- Exercises
- Course Summary & Course Evaluation