

TECHNICAL TRAINING SOLUTIONS

ELECTRICAL COURSES

INSTRUMENTATION COURSES

MECHANICAL COURSES



PRACTICAL ELECTRONICS

COURSE 565: 5 DAYS: Max 8 Candidates

A basic electronics course for candidates who wish to explore the fundamental building blocks of electronics. The course employs a practical approach based on simple explanations and hands-on exercises. A good precursor to the electronics fault finding (570) course.

PARTICIPANTS

The course is intended for anyone interested in the electronics field and assumes no prior knowledge or for those that have studied the theory of electronic components and circuitry but have little experience of the practical application of that knowledge. Academic students of, for example ONC, HNC or HND electronics often find that this course provides the perfect complement to their studies.

COURSE PRESENTATION

The course provides participants with an understanding of the various commonly-used electronic components and how they would be employed in practical electronic circuits. Participants then build circuits incorporating these components and explore the functionality of them. We then make modifications to the circuit parameters by changing component values and measuring the effects. The course progresses from basic discrete electronic components like transistors and by the end of the course reaches components like analogue to digital converters (ADCs).

COURSE OBJECTIVES

On completion of the course, participants will be able to

- read electronic circuit diagrams and build small circuits
- understand the operation of electronic components within circuits
- determine the optimum / required values of circuit components
- use electronic test equipment to analyse circuits (oscilloscopes, logic probes, function generators etc)
- design and build an electronic circuit that incorporates ADCs, digital logic, analogue operational amplifiers and associated discrete components.

Successful completion of the course leads to the award of the Technical Training Solutions Certificate of Competence 565: Practical Electronics.

What do candidates on the Practical Electronics course actually do?

We begin with a recap of electrical principles. We remind the candidates about ohm's law, the power law, series and parallel networks, etc. Some of the candidates will have studied these before but we need to make sure everyone has the basic understanding before we proceed.

Then we look at capacitors and inductors, how they work and how they can be used, then look at low and high pass filter networks. We build some of these networks then test them with the function generators to see what sort of frequency response they have. We finish the first day by looking at semiconductors and LEDs.

Power
When most components (especially resistors) have a current passed through them they will produce heat as a by-product.
To ensure that the component can withstand the heat they must be the right "size". The unit of power is the Watt (W) and with resistors not only is the ohmic value important, so is its power rating. The power that gets dissipated in a resistor is the product of the current flowing through it and the pd across it, so a resistor that has 20V across it with 2A flowing through it will need to be rated to at least 40W – not all resistors are quite large in order for it to dissipate the heat generated.
Power is additive which means the total power consumed by the circuit is the sum of the individual components in that circuit.
The relationship of voltage, current, resistance and power is shown below.

Scientific Notation
In electronic circuits the amounts of current flowing, for example, can be very small, eg 0.001A. A shorthand method of representing this is to use scientific notation – using ten, raised to powers of 3, 4, or 9 etc, or reduced to powers of 3, 4, 9 etc.

$10^3 = \text{Kilo} = \text{K} = 1,000,000,000$
 $10^6 = \text{Mega} = \text{M} = 1,000,000$
 $10^9 = \text{Giga} = \text{G} = 1,000$
 $10^{-3} = \text{milli} = \text{m} = 0.001$
 $10^{-6} = \text{micro} = \mu = 0.000001$
 $10^{-9} = \text{nano} = \text{n} = 0.000000001$
 $10^{-12} = \text{pico} = \text{p} = 0.000000000001$

This would then allow 0.001 A to be written as 1mA. Other measurements in electronic circuits would be denoted in a similar way. Measurements of 1µV (0.000001V), 12mA (0.012A), 0.001A or 10mA (0.010A) may be encountered.

Page 11 of the Practical Electronics course notes, discussing the complex forms of Ohm's law

Practical 2: Differentiator
Build the following circuit:

Using a waveform generator with a square wave output set to 50% of 1V pp, observe the output on the oscilloscope.
By inputting different frequencies and observe how the output changes.

INSTRUCTOR'S NOTES:
Lower differentiated waveforms are and higher frequencies are.
Increase f and show the waveform DC component creeping up.

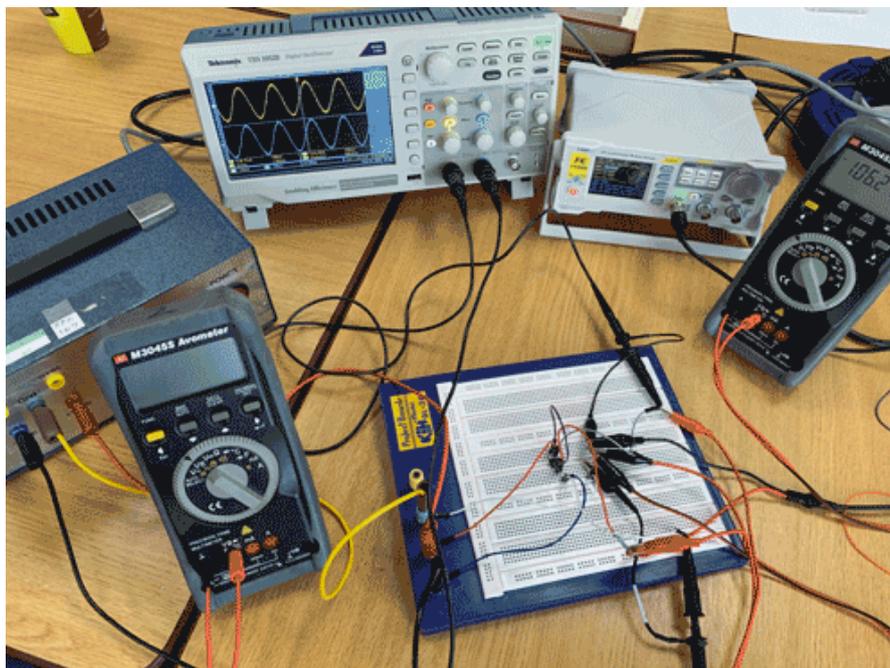
Page 19 of the Practical Electronics course notes, exploring how integrators and differentiators work

The junction of the n-type and p-type material would be electrically neutral and would have no free electrons or holes. This region is known as the depletion layer. When the depletion layer gets "thick" enough the attraction of the holes to the electrons would not be strong enough for the electrons to pass through the depletion layer. After the junction is formed there will exist a substantial hole on one side of the depletion layer and electrons on the other. The junction thus formed is known as a PN junction.
If a voltage was applied across the ends of the PN junction then it is possible to persuade the electrons to jump over the depletion layer. This happens as forward biasing the junction. The ends of the PN junction are known as the cathode and anode.
The voltage required to forward bias a PN junction is typically 0.6V with the positive voltage being applied to the anode and the negative side to the cathode. If the voltage polarity was reversed then the depletion layer would get larger and no current would flow. This is known as reverse biasing the junction.
In effect we have a device that will only allow current to flow in one direction only and is known as a Diode.
There are many different types of diode depending on the application. The most common are multi-layer signal diodes, power diodes and light emitting diodes (LEDs) but there are others:

- Constant Current Diodes
- Schottky Diodes - have a low forward voltage drop and a very fast switching action
- Shockley Diodes - have a negative resistance characteristic
- Step Recovery Diodes - used to generate very short pulses
- Tunnel Diodes - used in microwave oscillators and microwave amplifiers
- Varactor Diodes - variable capacitance used in reverse bias mode
- Laser Diodes - produce light, wavelengths in the 375 - 3000 nm range

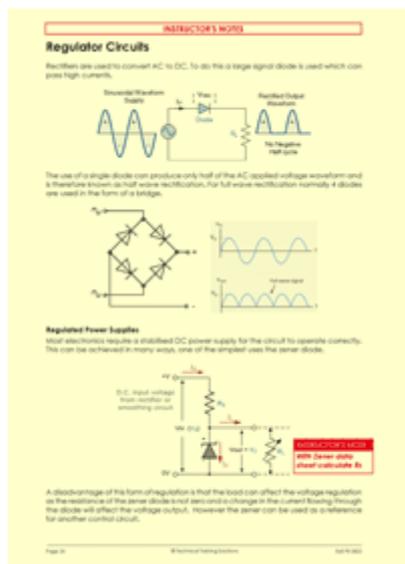
Page 21 of the Practical Electronics course notes, where we look at the various types of LEDs in common use

At strategic points on the course we do practical exercises that reinforce or explore the technical issues. These circuits are built on our breadboards and each candidate has their own test equipment including oscilloscope, multimeter, function generator and power supply, etc.

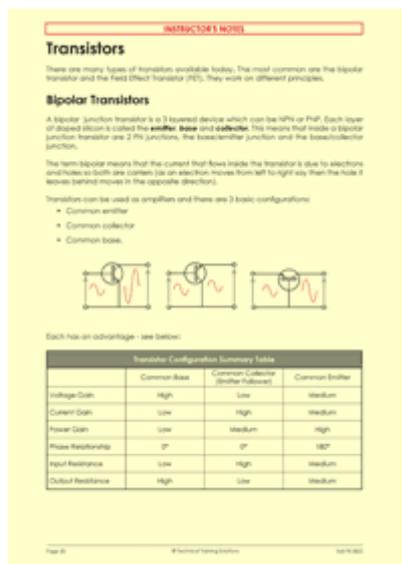


The test gear that each candidate uses

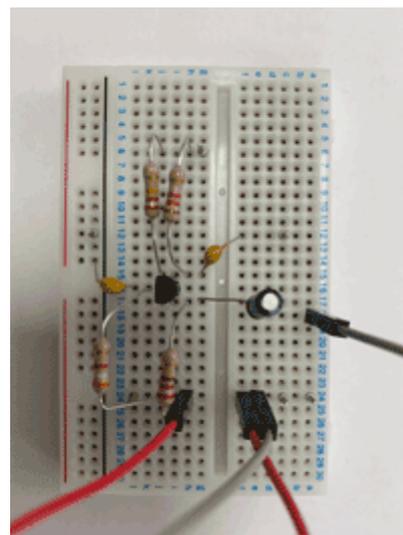
Next we look at rectification, voltage regulators and transistors. We look at how these circuits might be integrated to form a full power supply unit. We build various circuits to explore and prove the operation of these circuits.



Page 24 of the Practical Electronics course notes, exploring rectification and shunt regulation

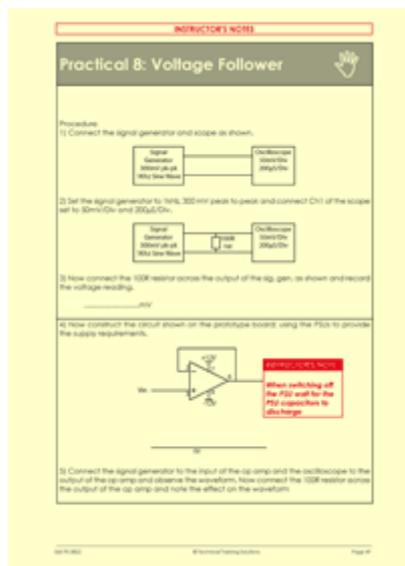


Page 30 of the Practical Electronics course notes, discussing how transistors are biased and what modes they are used in

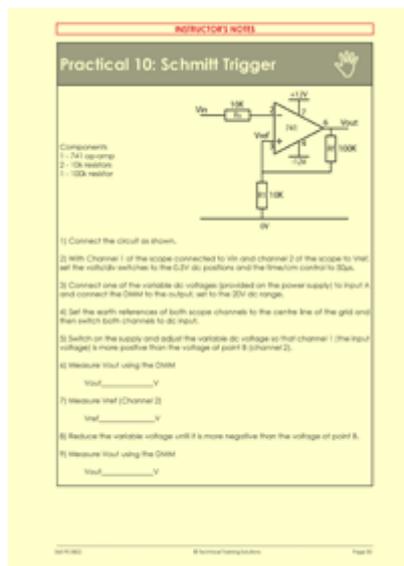


One of the practical exercises where our candidates build a single stage Class A transistor amplifier

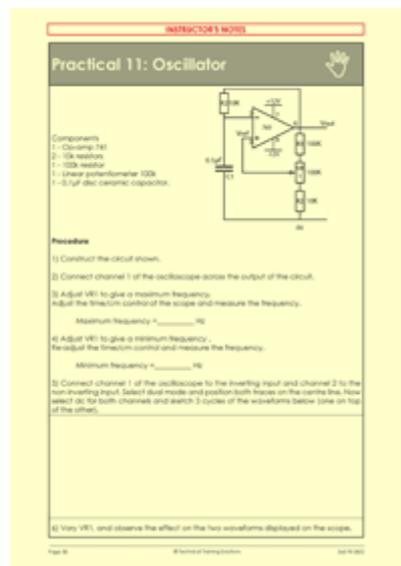
Op-amps are used in many electronics circuits, hence it's important that our candidates gain a proper insight into their uses, configurations, limitations and applications. We look at op-amp circuits like comparators, inverting amplifiers, summing amplifiers, buffers, ac amplifiers, schmitt triggers, oscillators and integrators.



Page 49 of the Practical Electronics course notes, where we do a practical exercise building a voltage follower circuit

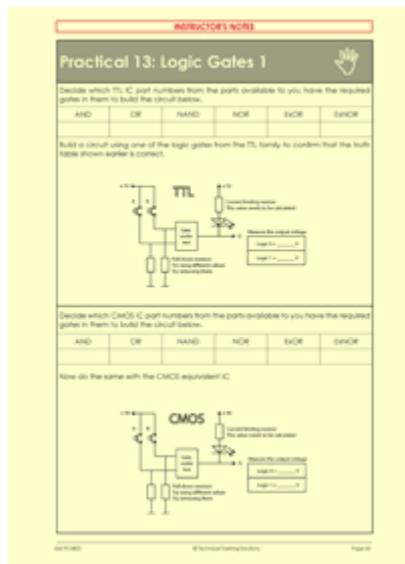


Page 55 of the Practical Electronics course notes, where we do a practical exercise building a schmitt trigger

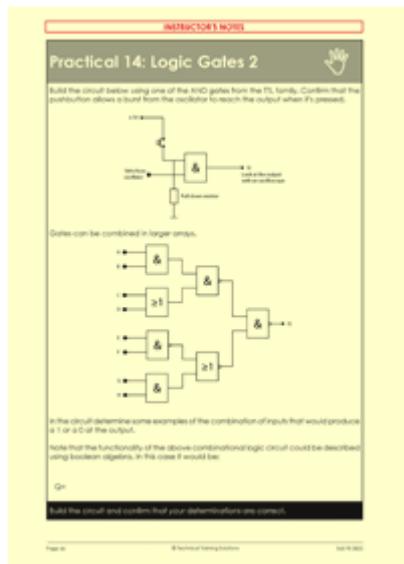


Page 58 of the Practical Electronics course notes, where we do a practical exercise building an oscillator

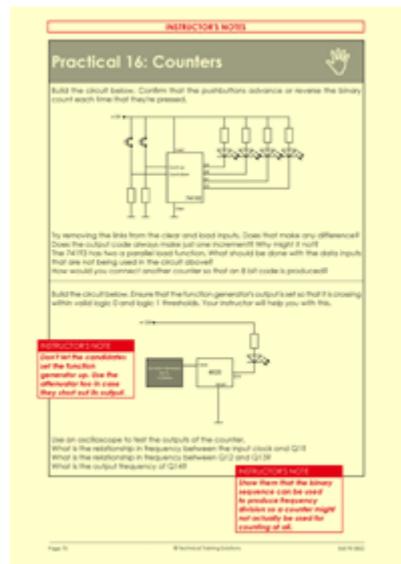
Then we look at digital logic circuits. We look at the main logic families (TTL and CMOS), studying their input and output stages, the common gates that are available, and the more complex functions that are used.



Page 65 of the Practical Electronics course notes, where we do a practical exercise exploring the worst-case logic levels of TTL and CMOS



Page 66 of the Practical Electronics course notes, where we do a practical exercise looking at how logic gates can be combined to produce complex functions



Page 70 of the Practical Electronics course notes, where we do a practical exercise getting a digital counter to increment and decrement its values

