



Welcome to the Electronic Systems Engineering Laboratory!

While we are certain that you are raring to start off to a challenging and enjoyable academic year, we also understand that there are several areas where you could do with some guidance and friendly advice. One such area is deciding on a toolkit that you will need to use during your lab-work.

You do not need to spend the earth on a whole lot of sophisticated tools, however you *do* need to be reasonably equipped if you are to make the most of your practicals. We have therefore compiled a list of essential items and we are also providing you with a guideline of what we consider to be a reasonable price for each item. These can be purchased locally or from the internet and we suggest you do some diligent shopping before you actually make any purchases, otherwise you could well end up running into a lot of needless expense. At the other end of the scale, you need to avoid buying tools that are flimsy and which would probably wear out by the end of the first term!

So, let's get started!

Multimeter

Typical price range: €25- €40 each

Qty: 2



This is one of the more expensive items in your shopping list but one which, with reasonable care, you will continue to use for many years after your graduation!

Below is a specification of a typical, useful and versatile model. We strongly recommend that you purchase two of these since there will be several occasions where you would need to read voltage off one meter and monitor current readings from the other. However, if you are on a tight budget, you could get away with purchasing one meter for the first term and then plan on a second purchase later during the academic year. Furthermore, the multimeters need not be identical – in fact, it could well be the case that the recommended features listed below, could be obtained through the combined features of two separate models.



We recommend the following specifications as a general guide:

Selection	Accuracy	Range
V_{dc}	$\pm 1\%$	200mV - 600V
V_{ac}	$\pm 1\%$	200mV - 600V
I_{dc}	$\pm 1.5\%$	2mA - 10A
I_{ac}	$\pm 2\%$	2mA - 10A
Resistance	$\pm 1\%$	200 Ω - 2M Ω
Recommended extra features:		
Frequency	$\pm 1\%$	2kHz-10Mhz
Capacitance	± 3 to 5%	20nF-200uF
hfe	$\pm 3\%$	0 - 1000
Inductance	$\pm 3\%$	2mH-20H
Temperature	$\pm 1\%$	-20C to 200C

What to look out for:

If you are buying the meter locally, take a good look at the overall finish and appearance of the model.

- How is the overall appearance? Does it look reasonably robust and well-finished?
- How is the feel of the selector switch? Does it give a good, positive indexing click? ..or is it just a dubious, soft, 'sliding' sort of movement?
- Is the display bright, clear and easily visible at an angle?
- Do the leads look strong and well finished or do they look flimsy? How is the fit of the plugs of the leads into the meter? Do they lock-in with a positive feel, or is the fit too loose?
- Open the battery compartment is the fuse visible? If not, chances are that the fuse may be soldered directly onto the PCB – this saves the cost of a proper fuse holder on very cheap models. Avoid such cheap models!
- What type of battery does it take? Most good models use a 9V, PP3 battery and provide a good connector but some use smaller batteries with flimsy contact arrangements - so beware!



Breadboard

Typical price range: €15- €30

Recommended Qty: 1

No, this is not something you prepare your ham & cheese or chicken-mayo on!



You will need a breadboard to build actual circuits from your circuit diagrams without having to solder the components. This means that you can very easily insert or remove components, alter wiring and experiment to your heart's delight! As such, it is an invaluable learning tool that can be used for literally hundreds of different circuits. A good sized model would be about 20 x 15 cm. Ideally, it should include at least two or three banana sockets, (four are shown in the picture, next to the label). These are useful to easily power up or disconnect the breadboard from the power supply. Some models come complete with wires and jumpers as shown. This is nice to have but not an absolute requirement since you can easily make such jumpers yourself.

What to look out for:

If you are buying locally, take a good look at the overall finish and appearance of the model.

- Check that the plastic is not warped and that a transistor or small resistor can fit in comfortably and securely.
- There should be at least three vertical double column strips running along the length of the breadboard. These are for easy hook-up of power to the components. They look similar to the horizontal strip shown towards the top of the picture but in a vertical orientation. Incidentally, the horizontal strip shown in the picture is not really that important.

You will also need to buy some wire that will fit into the holes of your breadboard. This would be single core, solid type, gauge 22 thickness. About 5 metres each, in 5 different colours, should be just right; one pair should preferably include red and black colours.



Oscilloscope BNC probe

Typical price range: €10- €20

Recommended Qty: 2



You will need oscilloscope probes when working with an oscilloscope. The lab will, of course, provide the oscilloscopes but unfortunately through a lot of use, (and misuse!), these tend to wear out quickly and it is becoming prohibitively expensive for the department to keep replacing these on a frequent basis.

However, with proper care, these will last you for several years and it is useful to have a pair of extra probes should you decide to purchase a scope of your own in future.

What to look out for:

If you are buying locally, take a good look at the overall finish and appearance of the probe.

- An attenuation switch giving two possibilities X1 and x10 should be fitted as a standard on the probe.
- Better models allow the probe head and the measuring tip be removed from the cable allowing for economical replacement of broken parts.
- Good quality probes are also provided with a trimmer on the BNC connector to optimise matching of the probe with the scope being used.

We recommend the following specifications as a general guide:

Bandwidth	$\geq 15\text{MHz}$
Input Resistance (x1)	$1\text{M}\Omega$
Input Capacitance	46pF
Max working Voltage	600V
Length	$\approx 1\text{m}$



Oscilloscope BNC – crocodile test lead

Typical price range: €5- €10

Recommended Qty: 1



This is a simple straight-forward test lead that is quite convenient for simple and quick measurements such as dc voltage measurements etc. since you can leave these connected to the part of the circuit being tested, leaving your hands free for other measurements.

Crocodile Clip Set

Typical price range: €10- €15

Recommended Qty: 1set- 10 pieces



These crocodile clip sets really come in handy because you can quickly clip test leads from your multimeter to resistor leads or to power supplies etc. freeing up your hands to handle other more important tasks. Obviously these are for use on low voltage systems, certainly, below 30V.



4mm Banana to Banana Cables

Typical price range: €12 - €15 for the set

Recommended Qty: 6 pieces



Once again, these cables are very useful to connect power supplies to breadboards or to hook up a multimeter to a power supply for extended monitoring of current or voltage etc. Ideally, one pair should be red and black while the remaining ones may be different colours. It is useful to get the stackable type since these are more versatile.

The ones shown here are shrouded i.e. the pin is also covered by insulation but others with bare pins are quite acceptable since, as already mentioned, these are strictly meant for low voltage use.

Through-hole Resistor kit E12

Typical price range: €10 - €20

Recommended Qty: 1 kit – approx. 240 pieces



You will certainly be using resistors in practically all your lab work throughout the course, so this small investment will more than pay for itself. Rather than buying these separately, it is usually more worthwhile to get a kit which will include a wide range of values usually from about 1Ω to $1M\Omega$.

E12 means that there are 12 stages from one decade to the other: You will get 1; 1.2; 1.5; 1.8; 2.2; 2.7; 3.3; 3.9; 4.7; 5.6; 6.8 and 8.2. The E24 range provides a finer selection since there are twice as many values – for example between the values from 1 to 1.2 in the E12 series, you will get 1; 1.1 and 1.2 in the E24 and so on. However the E12 is good enough for starters.

The resistors should be of the through-hole type as shown in the picture and they should be rated at about $\frac{1}{4}$ W and 5% tolerance.



Hand tools

Typical price range: €40 - €60 for the whole set

Recommended Qty: 1 each

There is a huge variety of tools, types, quality and prices, so once again, shop around. It is usually safer to go for a known brand, but in any case, a price of about €7 for each of the tools shown and around €15-20 for the toolbox should make a reasonably good buy.



Cutter



Long Nose Plier



Jeweller screwdriver set



IC Extractor



Wire stripper



Toolbox



Optional equipment

The following is equipment you would not need immediately for your course but would be necessary in the second semester of your first year.

Soldering iron

Soldering iron & Stand:

Typical price range: €20 - €35

Recommended Qty: 1

Simple Soldering Iron



Soldering Iron



Stand

A soldering iron is an indispensable tool in electronics work. Breadboarding is great for prototyping and experimenting work but there will be instances where you would need a more permanent solution such as when you are doing a project. For starting off, a simple soldering iron as shown above, together with a stand, will be quite sufficient. The iron should ideally be rated at about 25W, you can get irons rated at 15W, but these tend to be inadequate for soldering larger components such as power transistors. On the other hand, do not go for an iron much above 25W, since this may prove too crude for electronics work. You will also need a simple stand with sponge. This keeps your iron safely in place during intervals while soldering ... and here's a small tip, do not leave your iron needlessly on as this quickly reduces the lifetime of your tip.



What to look out for:

If you are buying locally, take a good look at the overall finish and appearance of the iron.

- Make sure that it is earthed! An unearthed iron is unsafe both for you and the electronic circuits you solder, due to possible leakage currents that may damage sensitive components.
Avoid purchasing your iron from an ironmonger, (pun not intended!), as chances are that their products would be general purpose type and not specifically designed for fine electronic work.
- Check how the replacement bit is secured to the element. Most modern designs are simple slide in/out arrangements. Some crude designs secure the bit by means of a screw, this is not very reliable as the screw tends to rust and jam up at times!
- Check that spare bits for your iron are readily available. We recommend a 2mm chisel bit and a round pointed one. Avoid excessively thin or narrow bits as these tend to wear out very rapidly!
- Check that the cable is reasonably soft and flexible: some irons have cables that are stiff and this can considerably restrict free movement when soldering.
- Check that the iron feels comfortable in your hand that it is not too large or heavy!

Alternative to soldering iron:

Soldering Station

Typical price range: €70 - €120

Recommended Qty: 1

Soldering Station



A simple soldering iron is ok for most applications however such devices are limited in scope since their inherent simple design does not provide for close temperature control. Hence their utility becomes somewhat marginal in sensitive applications where close temperature regulation and stability is critical.

A soldering station provides far superior temperature stability, better thermal capacity and virtually no risk of leakage currents.



Up to a few years ago, we would not have dreamed of suggesting the purchase of a temperature controlled soldering station to our students since prices for these would *start* at somewhere around €300! Nowadays it is possible to get a good, basic model for about €100 or even less. However if this is going to put a strain on your budget, do not worry, a simple soldering iron as described earlier will happily see you through - certainly for the first year!

What to look out for:

Most of the advice given for the simple soldering iron given earlier, applies to the soldering station but in addition, you will do well to check out the below:

- Have a look at the manual and check the specifications.
- Check that the unit is ESD compliant
- Digital temperature display
- At least 1 year warranty

Power	30W – 50W
Temperature range	200 – 450C
Temperature Regulation	± 5C

Solder

Typical price range: €10 - €20

Recommended Qty: 1 reel - approx. 250g weight



Whatever type of iron you decide to buy, it will be pretty useless without some solder!

So you will need to buy a small reel specifically designed for electronic work. A 250g reel will most likely last you for the whole of your course and probably beyond!

The solder should be flux-cored meaning that it will inherently contain flux which will greatly ease the soldering process. The gauge should be about 0.7mm.

It is useful to note that there are two main types of solder: leaded and unleaded. Unleaded solder is not as easy to use as the leaded type since the latter type tends to flow more easily. However with some practice, both can be used effectively.



Solder Pump

Typical price range: €5 - €10

Recommended Qty: 1



A desoldering pump enables you to undo wrong connections by sucking up the solder from a soldered joint. Basically, you press the spring loaded plunger right down and this locks in. Next, you hold the soldering iron in one hand, apply the heat to the joint for about 2 to 3 seconds to melt the solder, then with your other hand, you bring the tip of the solder pump next to the joint and press the round button just below the plunger. This releases the plunger and sucks up the solder.

Desolder wick & Flux dispensing pen

Typical price: €10 - €15 for the set

Recommended Qty: 1 of each



A desoldering pump is great for removing the bulk of the solder, but for a really good clean-up job, a good solder wick will 'mop-up' all the remaining solder and also flux-up the area for eventual resoldering if required.

A 2mm wide braid is just about the right size.

Another useful aid to soldering is a water soluble flux pen which cleans the copper area to be soldered and facilitates soldering.





Tweezers

Typical price range: €3 - €5

Recommended Qty: 1



A pair of tweezers, preferably ESD protected, come in really handy for picking up and placing small delicate components.

Veroboard

Typical price range: €5 - €10

Recommended Qty: 1



Ok you've got the soldering iron, the solder and a bunch of tools, all you need now is something to solder onto! This is where the board on the left fits in perfectly. This is basically a fibre-based board with strips of copper running parallel to each other. You can break off the strips to make a break in a connection using a small drill – but we'll talk more about that when you actually come to use it!

A board about 10 by 16cm with 2.5mm pitch, will be just right to start off with.



Concluding Note:

The total cost of tools required for ESE lab sessions, may amount to something around €200. Admittedly, this is not a small amount, but this should be considered as essential courseware that is as indispensable as a laptop or textbooks. Moreover, you will be equipped with a set of basic tools which you will continue to use well beyond the duration of the course. Please note carefully that you are required to bring the full tool-kit described above, each time you have a lab session. Without this kit, you will be unable to perform any of the experiments; hence it is essential that you make sure that you purchase the listed items by not later than the fourth week of the first semester.

The ESE department is providing lockers which can be used for safe-storage of your toolkit. Having access to a locker, will save you the trouble of carrying the toolkit around with you on the days when you have a lab session. In addition, the lockers will also double up as storage space for your backpack during a lab session since once you remove the toolkit, you can then put in the backpack for the duration of the lab session. Please note that bags/backpacks etc. are strictly not allowed within the laboratory.

As always, the staff at the laboratory will be more than happy to help you at any time should you need further assistance or advice ...so please feel free to ask!