School of Aerospace, Mechanical and Mechatronic Engineering

Raymond Kirby Robotics Teaching Laboratory
Introductory Notes

The Raymond Kirby Robotics Teaching Laboratory — previously known as the Mechatronics Lab—is Room 330 in the Link Building. Note that the Lab is accessible from level 2 of the Electrical Engineering Building. It is a special-purpose computer lab that is provided for mechatronics students, and can generally be used Monday to Friday during normal business hours. We are offering you the privilege of working in the Lab with minimal supervision. In return, you must agree to take all steps necessary to safeguard the lab and its facilities, and to maintain safe and pleasant working conditions. To begin with, we ask that you read these notes thoroughly, and then follow the rules set down here.

1 Use of the Lab

- The Lab is generally available (an “open Lab”) to Mechatronics students for use between the hours of 7:00 am and 6:00 pm, Monday to Friday, unless it is booked for a class. Class bookings will be posted on the Lab door.
- Users are allowed to use the Lab facilities for work in the designated subjects only, not for personal use or for other subjects. This is a special-purpose lab supporting specific microprocessor and computer engineering subjects.
- Authorized Lab Users include: any student enrolled in the subjects MTRX1701, MTRX1702, MRTX2700, MRTX3700, MTRX5700, AMME4790, MECH5720 or AMME2700 in the current semester, or (with the approval of the student’s supervisor) undertaking thesis work in AMME4111/4112 or project work in AMME4121/4122, plus the Tutor(s) and Academic Staff associated with these courses.
- Physical access to the Lab is by an electronic swipe card. Outside of scheduled class hours, you can make arrangements with the subject Tutor(s) to let you into the Lab. The Mechanical Engineering Building Attendants (S142, building J07) can also let you into the Lab.
- Students enrolled in the designated subjects will have access to the Lab added to their student card. This will be done automatically, usually around the end of week 2 of a semester.

2 Rules, Rights and Responsibilities of Users

All Lab Users have certain rights and responsibilities, and must agree to follow the rules:

- For safety reasons there must always be at least two people in the Lab. See the section on WHS later in these notes.
- You are permitted to eat or drink ONLY in the section at the back of the lab, due to the increased risk of damage to yourself or the equipment, and because of the mess it inevitably makes. Better still, take a break — go sit on the lawn, relax and smell the sunshine…
- Respect the test equipment, and be gentle with it. If you don’t know something about a circuit or electronics hardware, ask before rushing ahead. Some of the equipment is quite expensive, and (perhaps more importantly) is impossible to replace at short notice.
- You must not open the PC cases or install additional hardware or software on the Lab computers. If you think that there is a need, please speak to one of the Tutors or Lecturers.
- It is your responsibility to keep the Lab neat and tidy. Electronic prototyping and computer work tend to generate mess. When you are finished your session, tidy things up for the next
person who will use the Lab Workstation. Put unwanted papers in the paper recycling bin, throw out small scraps of wire (don’t sweep them onto the floor), etc. All benches should be clear of everything except keyboards and mice. You should aim to leave the Lab neater than you found it.

- **Please report any problem**, including damage to equipment, as soon as it occurs. If you break something, own up! Problems may involve the network, Lab server, computer workstation, specialized lab equipment, application software, operating system, usage, etc. It is important that we have as many details as possible so that the problem can quickly be fixed. To report a problem:
  - Send a report by email to mxlab@acfr.usyd.edu.au so that we have written information on the problem. Make sure that you identify which circuit board, computer, network port, etc. has the fault, and provide as much detail as you can;
  - Speak to a subject Lecturer or Tutor if one is in the Lab. If the problem is urgent, seek out and speak to a Lecturer or Tutor;
  - If the problem involves the possibility of injury to people or damage to equipment, isolate equipment involved from energy sources (e.g. 240V AC) and tag it with a warning label. Warning labels are stored in the small box near the door to the preparation room at the back of the Lab. Please put your name and the date on any tags that you write.

- **Lockers** may be used under the following rules
  - Lockers are for the use of Mechatronic Engineering students enrolled in a subject that uses the Lab.
  - One locker per student, allocated on a first-come first-served basis.
  - Students must always have their real name or email address on a card (70 x 35) in the card holder of the locker that they are using so that they may be contacted.
  - Students must supply their own padlock.
  - A locker can be used for one semester only. All lockers must be cleared by the last day of exams in each semester. Padlocks will be cut off and locker contents disposed of after this date.
  - There must be no food stored in lockers.
  - Students who damage or deface lockers will be required to pay for repairs.
  - There will be no charge for locker use.

- The last two people out **must secure the Lab**, as follows:
  - Turn off all **PC monitors** and instruments – the **PCs should remain powered**;
  - **Close the windows**;
  - Turn off all lights;
  - **Make sure that the door is locked behind you**;
  - **Check the door again**.

User behaviour will be monitored by course Tutors/Lecturers. Sanctions may be imposed upon people who breach the rules, including exclusion from the Lab for a number of weeks, or referral to the Registrar for further disciplinary action.

### 3 Work Health and Safety (WHS) in the Lab

It is said\(^2\) that the “accident rate in schools and colleges is 100 to 1,000 times greater than [in industry]”. As you learn about engineering and scientific principles it is also important that you learn about safety. Risk assessment and safety is a very important part of professional engineering practice these days. To work safely in the Lab means that

- **You know** the hazards;

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1 Some of this material is abstracted (with permission) from a document prepared by Michigan State University.
You know the likely and worst incidents that could happen;
You know what to do and how to do it if they should happen;
You know and use practices and protective equipment to eliminate or control the risks.

3.1 WHS in Australia

Occupational health and safety law in Australia prior to the 1980s was highly detailed and technical. It seemingly tried to list all workplace dangers and to prescribe ways of making those dangers safe. Most Australian states, including NSW, now follow a risk-based approach to WHS.

The essence of this type of approach is that it
- Accepts that hazards will always exist in any workplace and cannot practically be eliminated
- Identifies hazards present in the workplace
- Classifies the severity of each hazard according to a) the likelihood that personal injury or property damage will occur and b) the severity of any resulting injury or loss of property
- Controls each hazard so that the risk is reduced to an acceptable level, first focussing on the most severe hazards.

University policy requires all staff members to follow its procedures\(^3\) for hazard identification and control. Students, as “persons legally in the workplace”, also have a legal responsibility to identify risks and report them to staff. We – staff and students in the Lab – are therefore responsible under NSW law and University policy for making sure that we all remain safe.

The main hazards in the Lab have been identified as
- Slips, trips and falls;
- Electrical hazards.

The probability of either of these happening is assessed as small, provided that safe practices are observed. The following sections describe some of these practices.

3.2 Slips, Trips and Falls

Injuries in the workplace are most likely to be caused by very common hazards – the ones that no one thinks about. The danger of slips, trips and falls is one such hazard, and is probably the highest risk present in the Lab. This hazard can easily be minimised through some simple “housekeeping” rules
- Keep walkways clear of obstructions. In the Lab, this means placing your bag and jacket/jumper well under the bench, on top of locker banks or in a locker where it is not in anyone’s way. There may not be enough space on or under the benches for everyone’s gear.
- Don’t allow the spaces between benches to become crowded with chairs.
- Never run inside the Lab.
- Wipe up all spills as soon as they occur.
- Don’t allow rubbish to accumulate – put it in the paper recycling or rubbish as appropriate.
- Do not leave extension cords, leads, etc. trailing across walkways.

If you see any of these hazards, remember that you actually have a legal responsibility to make it safe.

3.3 Electrical Hazards

The severity and effects of an electrical shock depend on a number of factors, such as the pathway through the body, the amount of current, the length of time of the exposure, and whether the skin is wet or dry. Water is a great conductor of electricity, allowing current to flow more easily in wet

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conditions and through wet skin. The effect of the shock may range from a slight tingle to severe muscular contraction, to severe burns to cardiac arrest, depending on the voltage, current and the duration of the shock. Table 1 shows the general relationship between the degree of injury and amount of current for an 110V AC hand-to-foot current path of one second’s duration of shock. While reading this chart, keep in mind that normal 240V AC electrical circuits are rated to provide 10 A of current. Voltages as low as 40V can be dangerous. Human skin resistance is typically between 10 kOhm (dry skin) and 1 kOhm (damp or sweaty skin). 240 VAC / 1,000 Ω = 240 mA.

Table 1: Response of the human body to current – 110 VAC for 1 second.

<table>
<thead>
<tr>
<th>Current</th>
<th>Reaction</th>
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<tbody>
<tr>
<td>1 mA</td>
<td>Perception level</td>
</tr>
<tr>
<td>5 mA</td>
<td>Slight shock felt; not painful but disturbing</td>
</tr>
<tr>
<td>6 – 30 mA</td>
<td>Painful shock; &quot;let-go&quot; range</td>
</tr>
<tr>
<td>50 – 150 mA</td>
<td>Extreme pain, respiratory arrest, severe muscular contraction</td>
</tr>
<tr>
<td>1,000 – 4,300 mA</td>
<td>Ventricular fibrillation</td>
</tr>
<tr>
<td>≥ 10,000 mA</td>
<td>Cardiac arrest, severe burns and probable death</td>
</tr>
</tbody>
</table>

The major hazards associated with electricity are electrical shock and fire. Electrical shock occurs when the body becomes part of an electric circuit, either when an individual comes in contact with both wires of an electrical circuit, one wire of an energized circuit and the ground, or a metallic part that has become energized by contact with an electrical conductor.

3.3.1 Electrical Hazard Reduction

There are various ways of protecting people from the hazards caused by electricity, including insulation, guarding, grounding, and electrical protective devices such as fuses and residual current devices4 (RCDs). This section provides a set of simple rules aimed at reducing electrical hazards within the Lab. Most of the electrical hazards relate to 240V AC mains-powered equipment.

**DANGER!** Students are not permitted to work on circuits that are energised by 240V AC power under any circumstance. The phrase “work on” shall include activities such as opening the cabinet of a mains-powered instrument, and measuring mains-powered circuits with test instruments. This rule applies even if you are a licensed electrical contractor.

Electrical hazards can be reduced significantly by taking some basic precautions:

- Know the location of, and how to operate, the emergency electrical power isolator – it is tripped by either one of the red **Emergency Stop** buttons which are located on the
  1. **Front wall of the lab just to the right of the whiteboard** and
  2. **Left wall at the rear of the Lab**.

Use either button to instantly shut off all electrical equipment in the Lab in the event of electrocution or fire.

- Before each use, visually inspect wiring of mains-powered equipment for defects such as faulty insulation or loose connections. Do not use damaged or frayed electrical cords. Tag and report them as unsafe immediately.

- Remove metal jewellery, watches, rings, etc., before working on electrical circuits.

- Minimize the potential for liquid spills on or near electrical equipment. Never place containers of liquid, including beverages, on or near electrical systems.

- Always know the electrical ratings of equipment you use, and be sure you use that equipment within its ratings. Never overload circuits.

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4 Formerly known as earth leakage circuit breakers (ELCBs)
• Turn off power and unplug equipment before checking or replacing fuses. Locate and correct the cause of a blown fuse or tripped circuit breaker before replacing the fuse or resetting the circuit breaker.
• Never defeat the purpose of a fuse or circuit breaker. Never install a fuse of higher amperage rating than that specifically listed for the circuit.
• Complete all your wiring and check it carefully before turning on the power supply. If you are at all uncertain, have it checked by someone else – preferably a Lecturer or Tutor.
• When a setup or circuit is to be reconfigured or rewired, turn the power supply off. It is also good practice to disconnect it physically from the power supply.
• Make sure metallic equipment chassis or cabinets are earthed. Never cut off or defeat the protective earth connection on a plug.

3.3.2 Electrical Emergency Response
The following instructions provide guidelines for handling three types of electrical emergencies.

3.3.2.1 Emergency Electrical Power Cut Off (Isolator)
In the case of an electrical emergency, such as electrocution or fire, all 240 V general purpose power outlets in the lab can be isolated (turned off) manually by pushing either of the two red Emergency Stop buttons in the Lab.

3.3.2.2 Electric Shock
If someone suffers serious electrical shock, he or she may be knocked unconscious. If the victim is still in contact with the electrical current, immediately disconnect the electrical power source using either of the red Emergency Stop buttons: front wall of the lab just to the right of the whiteboard and left wall at the rear of the Lab. If the supply does not disconnect, try to separate the victim from the power source with a nonconductive object, such as a wooden-handled broom.

**Important:** Do not touch an electric shock victim who is still in contact with a power source; you could electrocute yourself.

Have someone phone for emergency medical assistance immediately (0-000 from an internal phone or 000 from a mobile phone). Administer appropriate first-aid. Notify the University Emergency Service by internal phone on 1-3333, or 9351-3333 from a mobile phone. Qualified First Aid Officers are available in RTCMA and the ACFR. They know the location of an automatic cardiac defibrillator and how to operate it. The nearest defibrillator is adjacent to the lift on the bottom floor of the Electrical Engineering Building.

3.3.2.3 Electrical Fire or Other Fire.
If an electrical fire occurs, immediately disconnect the electrical power source using either of the two red Emergency Stop buttons in the Lab, but only if you can do it without endangering yourself. If the fire is small, you are not in immediate danger, and you have been trained in fighting fires, use any type of fire extinguisher except water to extinguish the fire. The Lab is fitted with one CO₂ fire extinguisher that is suitable for most types of fire, including electrical fires.

**Important:** Do not use water on an electrical fire.

If the fire is not controlled, activate either of the Break Glass Alarms which are located just inside the Lab entry door and on the left wall towards the rear of the Lab. Both the Fire Brigade and the University Emergency Service will respond immediately.

If the fire is of sufficient size and located such that you cannot safely exit through the main Lab door, the Break Glass near the rear door will release the door, allowing you to exit through the Rio Tinto Centre.
If you are required to evacuate the lab you must go to the assembly point on the Engineering Lawn and wait there until you are released. You must obey the directions of the fire wardens who can be identified by their white hard hats or red hard hat (Chief Warden).

3.3.2.4 Live Conductors, Including Power Lines
Stay away from live conductors and downed power lines. Be particularly careful if a live conductor is touching a body of water. The water could conduct electricity. If a power line falls on your car while you are inside, remain in the vehicle until help arrives.

4 Laboratory Facilities
The facilities available to Authorised Users of the Lab are described in a companion document, “Laboratory Facilities”. This document is available in Adobe PDF form on the Lab website, http://www.aeromech.usyd.edu.au/MTRXLAB/.

5 Teaching and Assistance in the Lab

5.1 Scheduled Classes
Course Tutors and Lecturers will be available to provide assistance in the Lab during scheduled classes. This teaching assistance relates to the laboratory exercises, use of specific hardware and software, etc. We are also happy to answer ad hoc questions.

5.2 “Open” Lab Time
During “open” laboratory periods when no class is scheduled, Tutors or Lecturers will usually not be available in the Lab. Assistance should be sought by contacting your course Tutor by email or phone. Please be aware that you will not get immediate assistance, as we all have many commitments in addition to teaching. If you know that you will need assistance, it is wise to arrange a meeting in advance at a mutually convenient time.

6 Technical Support
Technical support for the Lab is provided by technical and professional staff of the ACFR on an as-needed basis. If you have a technical support question, please email it to mxlab@acfr.usyd.edu.au so that your question can be directed to the person best able to answer it.

7 Document Improvement
Should you discover errors, omissions or unclear information in this document, please report these deficiencies by email to mxlab@acfr.usyd.edu.au so that this document can be improved.

David Rye, Steve Scheding
July 2002
Revised August 2017

5 Hopefully not in the Lab!