MSc Robotics Dissertation Handbook

AY 2022-2023

Contents

1. General FAQs

When is the deadline for the dissertation project report?

5th September 2023

Is there a word limit for the dissertation project report?

A maximum of 15,000 words is suggested. However, this will not be enforced in the marking.

How should I begin my project?

- Set up regular meetings with your supervisor
- Plan project milestones
- Make use of tools to organize your project (Trello, Outlook Planner, Google Collab…)
- Discuss any potential health and safety issues with your supervisor
- Engage with the technical staff at the earliest opportunity for guidance on design, materials, equipment and health and safety. Often an early stage discussion with a member of the technical staff can ensure that you start on the right track and avoid issues further down the line.

What format should the dissertation be submitted in?
The official (accepted by University of Bristol and UWE) LaTeX template can be found on Overleaf here: https://www.overleaf.com/latex/templates/msc-robotics-project-report-uob-and-uwe/pxgfkghtptdq
Please take some time to read the template text which includes useful information on structuring the report.
You sign up to Overleaf for free using your university email address.
If you are unfamiliar with LaTeX: https://www.overleaf.com/learn/latex/Learn_LaTeX_in_30_minutes

What are 'chatbots' and why is their use considered contract cheating?
Contract cheating is when others complete an assessment for you. It is often in exchange for some form of payment but does not always include the exchange of money, goods or services. Artificial Intelligence (AI) applications, such as chatbots like ChatGPT, can generate responses to quite complex questions and these technologies are developing rapidly. Use of Chatbots or other AI applications, even if they are freely available, is a form of contract cheating because you are instructing a third party to complete the work for you. You can read about the University's policy on contract cheating here: https://www.bristol.ac.uk/students/support/academic-advice/academic-integrity/contract-cheating/

What if I need to apply for an extension?
Extensions must be applied for through our admin team (Engineering Maths Programmes Mailbox emat-info@bristol.ac.uk) and are only granted for extenuating circumstances (ECs). To submit Extenuating Circumstances, the guidance and a link to the form can be found here: https://www.bristol.ac.uk/students/support/academic-advice/assessment-support/ - extenuating-circumstances You will need to submit evidence. Loosing data due to a computer failure or loss does not count as an EC. Therefore, make sure you back up regularly your project in multiple ways (e.g., ONEDrive, Dropbox, GitHub, manually on an external hard drive, etc.)

2. Technical support for your project

Who can I ask for support with my project in addition to my supervisor?

To manage student support effectively, students from **MSc Biorobots and MSc Aerial Robotics (UoB Programmes)** should contact the **UoB Teaching Technologists** for support.

Students from **MSc Robotics (UoB-UWE joint award Programme)** should contact the **BRL Technicians**.

UoB - Teaching Technologists

- Pay us a visit at MVB 2.02 (immediately left through Woodland Road doors)
- eMail us at engf-tech-hub@bristol.ac.uk
- Book an appointment with a specific focus via our bookings page on Blackboard http://bit.ly/3FMUjAQ (Technical Training, Inductions & Advice – 1-1 Technical Advice)

UWE - BRL technicians:

- Julian Potter Julian.Potter@uwe.ac.uk
- Josh Minto Josh.Minto@uwe.ac.uk
- Ian Horsfield ian2.horsfield@uwe.ac.uk (Technical Manager for BRL)

What can the teaching technologists and technicians help me with?

- We provide practical technical advice
- We loan equipment
- We can help you find a project space

- We run skills-based workshops
- We author skill and equipment-based guides
- We signpost and help navigate the faculty technical workshops and laboratories to support your project(s).

If you are unsure about anything, particularly regarding health & safety and the use of equipment, please contact a member of the technical team and they will be happy to help. Please note, especially during busier times, it may be necessary to book a meeting with a technician, to ensure everyone has access to the help and advice they require. Because of this it is always advised to email in advance with some background on your project and what you require, as you may have to wait around for a while if you turn up unannounced.

What lab/workshop access is available?

University of Bristol (UoB)

Technical services have lots of spaces and services available, please see the Blackboard page for details: http://bit.ly/3FMUjAQ (if you are not already enrolled onto the technical services blackboard site you will need to self-enroll to see all the information). Your two main points of contact are the Hackspace and the Tech Hub:

Hackspace (Floor 1, Merchant Venturer's Building (MVB))

- Rapid prototyping – 3D printing, laser cutting
- Soldering and hand tools, general electronics equipment such as bench supplies and oscilloscopes
- Benches and storage for project work (Mon – Fri 9-5), see Blackboard page for details (Workshops: for your use – Hackspace)

Tech Hub (MVB 2.02 – Immediately left through the Woodland Road doors)

- Kit for loan – We have a selection of micro-controller and single board computers, sensors, motors, pumps and valves, cameras, VR/AR equipment and more. See the Blackboard page for details (Technical Training, Inductions & Advice – Tech Hub)
- Technical project advice – Please feel free to book a 30 min 1-1 with one of our Teaching Technologists via our bookings page on Blackboard (Technical Training, Inductions & Advice – 1-1 Technical Advice)

University of the West of England (UWE)

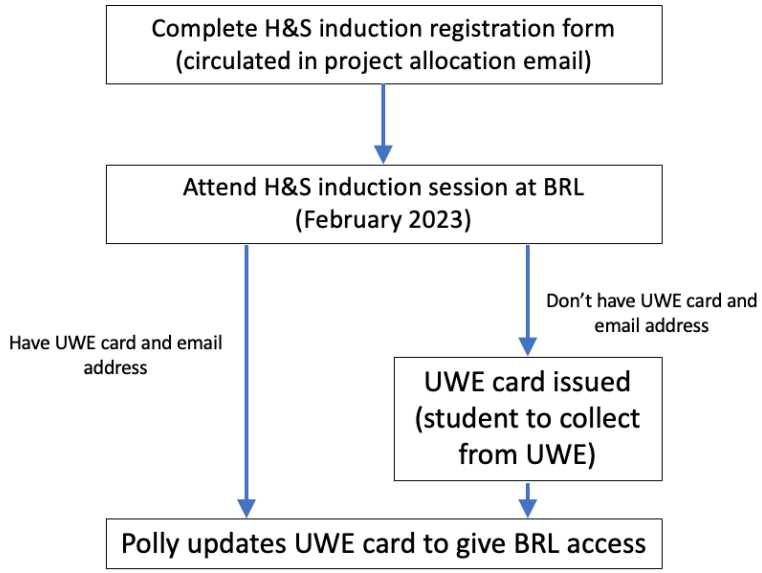
Bristol Robotics Lab (BRL)

- Rapid prototyping – 3D printing, laser cutting
- Electronics – soldering, oscilloscopes
- Kit for loan
- Usual hours for access to most BRL facilities is 9am-5pm Monday to Friday, though the student area is open 24/7 (swipe card required). Access outside of these hours may be granted upon request. The BRL technicians are available to provide support and supervision 9am to 5.20pm Monday to Thursday, and 9am to 4.10pm Friday.

You must complete a Health and Safety induction to get access to work at BRL.

A link to a form to book your induction will be circulated in your project allocation email.

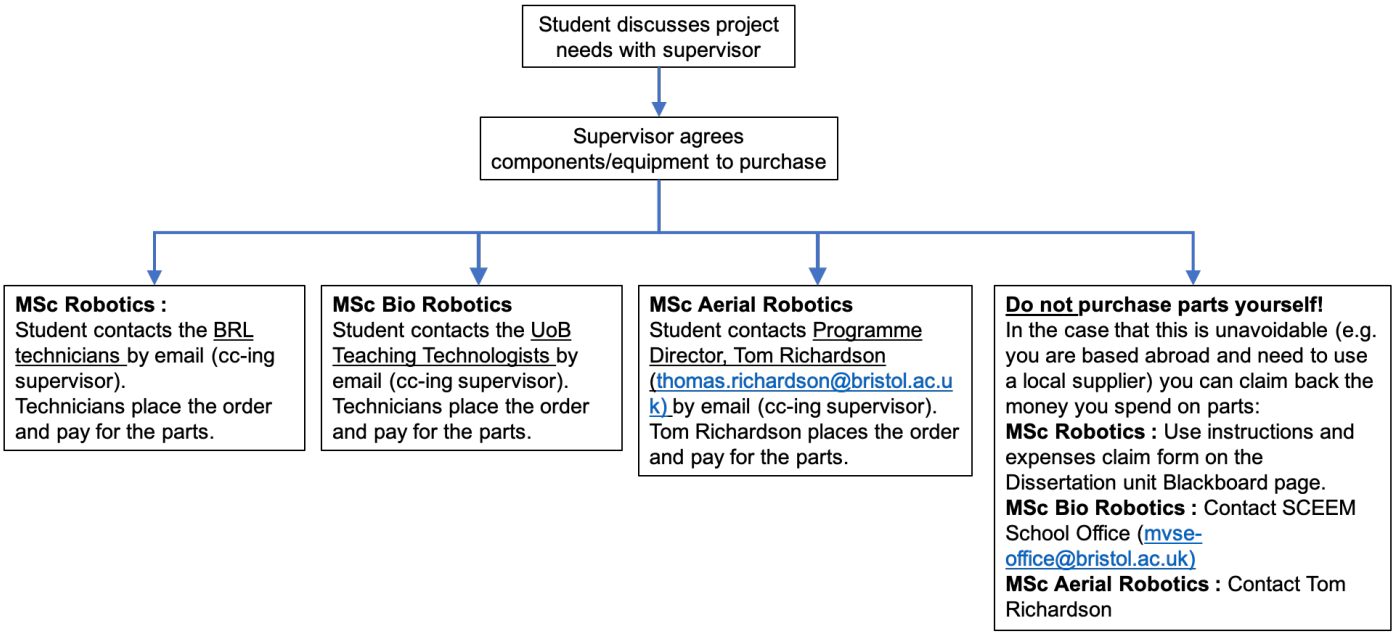
For questions regarding the Health and Safety induction please contact Polly Rai: **Polly.Rai@uwe.ac.uk**



3. Obtaining Components & Equipment

- **I need some components/equipment for my project, how do I obtain them?**

First engage with your supervisor to ensure you are on the right track with regards to equipment you may need to carry out your project. Once you have discussed with your supervisor and you are both happy, it is a good idea to engage with the technical team to see what BRL assets you can use and what components you may need to order. If you need to order components, please use the process specific to your degree programme, shown in the flow diagram:



The process of ordering parts / equipment for the dissertation project

- **I need to use components or equipment already in the lab, how do I do this?**

As above, please engage with your supervisor and the technical team to ascertain what equipment you need to use. We can then work together to determine your access, set up and timings, particularly for high demand items and those loaned from research projects. If you require 3D Printing, Laser Cutting or CNC Machining of parts, please see further info below

- **I need to order part; how do I do this?**

The current procedure is to fill out the order form we have, send an email to the technicians and CC your supervisor as they will need to authorise the purchase. We are reviewing this process at current and will keep you informed of any changes

- **How much budget is available for my project?**

Up to £100 per project.

- **What websites/retailers do you recommend?**

We usually use the bigger electronic sites for most of our robotics-based purchasing: RS Components, CPC/Farnell, RapidOnline and Digikey. Obviously not everything is available from these sites, so you may have to purchase things from Amazon, eBay etc, as well as other sites for more specialist purchases. Items must not be purchased from eBay, Aliexpress or Banggood and items may only be purchased from Amazon if available on the business site. The reasons for this are the availability of proper VAT invoices, purchasing from the UK where possible, avoidance of potentially hazardous items that do not have a datasheet, support of fair labour practices, and the proliferance of fake CE (UKCA) marking. Of course we will do our best to help find the item from a vendor that is compliant in the event of it being unavailable elsewhere.

Note also that UWE staff and students have access to discount rates when purchasing from RapidOnline (for any purchases you make, not just those for your project)

- **When can I expect my parts to arrive?**

Unfortunately, we can give no guarantees on this, as the order must be authorised at multiple levels, by your supervisor and by the University finance department. A good estimate is 1 week from emailing your order (depending on the suppliers delivery time), though this can take longer in busier times. Therefore it is advised to plan ahead as much as possible, to minimise delays with your project due to ordering. As above, the current process is under review and we will inform of any change

- **I have received my parts, but something is incorrect/missing from the order**

If this happens, please let whoever placed your order know and they will trace it back through the system and hopefully get you the correct or missing parts.

- **Can I keep the parts I have ordered at the end of my project?**

We ask that wherever possible you return anything you have used during your project so that it may be re-used or recycled for other students, even specialist parts that you have requested. However, you may keep specialised parts that have been 3D printed or machined as they cannot be re-used, as well as smaller electronic components such as circuit parts, wires etc if they are integrated into your 3D printed part for example. If you have parts such as this which you no longer want, please give these to the technical team and they will be happy to recycle them for you. If you have used any components that belong to you and you have bought yourself (without being reimbursed for them) then of course these remain your property and you may do with them as you please.

4. Making use of workshops and labs

Health & Safety

- **I am unsure how to carry out a particular task or process safely**

If you have already started this task, stop immediately. Any time you have concerns about your own ability to use tools safely, you should immediately stop using said tool and seek technical assistance. If you have not received an induction in the use of a tool or piece of equipment, you must not use it until such a time as you have completed the induction and training for it. As mentioned in the Workshop section of this document, if you need an induction to use the workshops, labs or any piece of equipment, please contact a member of the technical team.

- **I have witnessed someone carrying out an activity which I think is unsafe, or acting in a way that's dangerous**

The technical team are regularly in the labs and workshops and will be able to tell someone if what they are doing is unsafe. If however, you notice someone doing this and there is not a member of staff present, please bring it to the attention of one of the technical team immediately. Anyone deemed to be acting inappropriately or dangerously will be made to leave the labs immediately, undertake re-training or even banned from using the facilities. The lab follows the rest of the university in having a zero tolerance policy on drug and alcohol abuse, and anyone showing signs of these will be made to leave immediately and undertake re-training

- I h**ave noticed something about a tool or piece of equipment that I think looks unsafe, what do I do?**

If you are using the equipment, you must stop immediately (and switch it off if powered) and alert a member of staff immediately. If someone else is using it, tell them to stop as you think it may be unsafe, and alert a member of staff immediately. Do not attempt to fix equipment yourself, please notify a member of staff.

Access to Rapid Prototyping (RP) and Production Facilities

- **I need to produce a physical part, which materials/processes should I choose?**

We have several high-end pieces of equipment for MSc students to make use of including RP facilities, mechanical workshops and a large array of tooling and machinery. To decide the best approach for your project, first talk through with your supervisor and the technical team about what your aims are and what you actually need to build. Once this is determined, good practice is to refine your design as much as possible virtually (using CAD/CAM etc) and then move onto the production stage. This is usually done as follows for efficiency and operational reasons:

Laser cutting (where possible) → Verify Design → 3D Printing → Verify Design → Machining

This is because it is more efficient in terms of both time and material usage to make several attempts in laser cut acrylic that it is in printed ABS or machined aluminium. As with any other part of your project, the technical team will be happy to assist with your design, particularly designing for a successful print.

- **I have the finished CAD file for my design to be produced, what do I do now?**

Please send the file to the technical team, either in the form of an email or bring it along on a memory stick. The individual steps for each production process are shown below. Please be aware that it is best to plan ahead for anything you want making, as it is not always possible to turn up and have your parts made the same day,

especially during busier periods. Please also state the expected size of your design, as scaling and unit errors can sometimes happen when exporting CAD files as different formats.

- Laser Cutting

  Export your 2D object (or face of a 3D object) as a DXF file, and specify the approximate size of your piece, and the material and thickness you wish to use. See table below for more info.

- 3D Printing

  Please export your 3D designs as STEP files as these are preferred, though native SOLIDWORKS or Fusion360 files and STL files are also acceptable. Please note 3D printing is often in high demand across the lab, often there is a queue for the advanced machines which is why it is advised to plan printing as far in advance as possible and make yourself aware of lead times.

- CNC Machining

  We use SolidCAM or Fusion360 for CNC Machining, so native SOLIDWORKS or Fusion360 files are preferred, though STEP files are also acceptable. Machining is a lot more time and resource consuming than 3D printing owing to the greater complexity, so is only done on a limited basis. There is also often high demand and there may be a queue, so it is advised to plan any machining you may wish to do as far in advance as possible and make yourself aware of lead times.

Quick Lookup Table for different RP processes

Process	Preferred File Type	Materials[1]	Max size	Relative Lead Time
Laser Cutting	DXF	1, 2, 3, 5 & 10mm Acrylic	914x610mm	Short
3D Printing	STEP (SLDPRT, f3d, STL accepted)	Mainly ABS. Limited access to TPU, Polyjet and SLA materials	305x254x305mm	Medium
CNC Machining	SLDPRT, f3d or STEP	Aluminium, Acrylic, Acetal	500x500x225mm	Long

1 -Other materials may also be available, please discuss with your supervisor and the technical team

Designing for 3D Printing

- **How do I get some help or guidance with my design?**

Please contact a member of the technical team and they will be happy to help you

- **My part is too big for your 3D printers, what do I do?**

The bed sizes for the 3D printers at the lab are quite large, so it is unlikely you will have a part that goes outside these parameters. However, if this is the case, it is recommended to assess your design to see if it is necessary to print something so large, and if so, to break it up into smaller parts which can be assembled, or combined with laser cut or machined parts to achieve the same outcome

- **I have a very small or very accurate part that I want to print**

The best advice is to engage with the technical team on how to achieve this. The minimum layer height we can produce is 0.127mm and the machine tolerance is ±0.2mm, though in theory we can produce more accurate parts than this if needs be

- **How should I put a thread in my 3D printed part?**

When putting a thread onto a 3D printed part, the best and most durable way is usually to do it in post-processing using a tap rather than designing into your model. The reason for this is small threads (up to about M8 or so) tend not to resolve well during the deposition process for FDM, at least not enough to provide a durable and secure fixture. Therefore, it is advised to follow standard engineering practice for tapping threads, and design your hole smaller (or shaft larger) and manually create your thread after printing. Some advice on creating threads can be found here.

- **I want my part to be a particular colour, do you have any options?**

We mostly print using Ivory (off white) or Black filament. We order large spools of these filaments and tend not to swap them between jobs, so it is possible you may not get a choice in the colour of your part. If you require a specific colour for aesthetic purposes, it is usually recommended to paint your part during the post-processing stage. Speak to a member of the technical team about your requirements and we will be able to assist.

Workshop and Lab Use

- **I want to make use of the workshops to work on my project, how do I gain access?**

UoB
You can access the hackspace using your UoB student card once you have been inducted.
Again, the Blackboard site has details (https://bit.ly/3YdJJd3), you need to do an induction to the general space and then there are specific inductions for different equipment. The Technical Services policy is that every project should have a Risk Assessment that has been agreed with a supervisor to enable use of the spaces we manage. We are happy to review Risk Assessments or to help identify risks involved with a project and how to mitigate them.

UWE
In order to use the workshops or lab space, you must have a general BRL fire & safety briefing, as well as a local induction to the specific workshop itself. There are safety inductions and procedures necessary when using certain tools (even hand tools) which must be carried out before you are allowed to use them. Please contact the technical team if you need an induction or would like more information.
Depending on your experiment, it is likely you will need to conduct a risk assessment to ensure everything will be safe and managed well. Similarly, a COSHH assessment will need to be done for any chemicals you are using. Any necessary risk and COSHH assessments **must** be in place before any experiments begin. Risk assessments should be filled out by the student and the PI/supervisor, but the technical team can provide input and guidance.

In order to use the workshops or any tools within BRL, you **must** have received an induction. This is in addition to the general BRL induction/fire safety training that you should have already received.

Please note for tools, there is a 3 star safety rating system in the workshops, and depending on the safety status of the piece of equipment, you may need further training;

- 1 star equipment includes low risk items such as handtools, files, screwdrivers etc.

- 2 star equipment is higher risk and so requires induction, training and supervision by a member of staff until you are deemed to be competent, and includes tools such as the pillar drill, manual milling machine, vacuum chamber etc.
- 3 star equipment is staff use only and is reserved for high risk machines such as the lathe, grinding wheel and CNC milling machine.

The general workshop induction includes basic training and rules for the workshop, as well as inductions for the use of hand tools and battery drills, as these are the most common items. The sessions will generally be run on Tuesdays and take around 30 minutes, though BRL may re-arrange or re-schedule these depending on attendance and staff availability.

Sessions are currently planned for the following dates and times, though more will be added if there is enough demand. They are currently run by Robotics Technician Josh Minto, who will meet people in the BRL kitchen area at the stated time:

- Tuesday 23rd May 10:30am
- Tuesday 30th May 10:30am
- Tuesday 6th June 10:30am
- Tuesday 13th June 10:30am

To book a place, please contact Polly Rai (Polly.Rai@uwe.ac.uk) and Josh Minto (josh.minto@uwe.ac.uk) with your name and the session that you wish to book. Please do not attend unless you have a place confirmed, as the training can only be provided for a limited number of people per session.

- **I need to use a specific tool/machine in the lab for my project, how do I gain access and can I use any of this equipment (3D printers etc) myself?**

UoB

Again, on Blackboard there are details of specific inductions for hand tools, 3D printing and Laser cutting in the Hackspace. We may have inductions in the Tech Hub for certain items such as VR kit or Lipo batteries etc.

UoB students can also submit jobs to the Mechanical Workshop or the Electrical Workshop where appropriate. For details look on Blackboard http://bit.ly/3FMUjAQ (Workshops: Manufacturing Services)

UWE

Depending on the safety status of the piece of equipment, you may need an induction or a longer training session before being allowed to use it. There are 3 different safety ratings within the lab: 1, 2 or 3 stars. 1 star equipment are low risk items such as handtools, files, screwdrivers etc, which require a simple induction. 2 star equipment is higher risk and so requires induction, training and initial supervision by a member of staff until you are deemed to be competent. 3 star equipment is staff use only and is reserved for high risk machines such as the 3d printers, laser cutter, lathe, grinding wheel and CNC milling machine. Only members of staff are authorised and trained in the use of 3 star equipment, both for safety and insurance purposes. The technical team will be happy to assist you and operate this equipment for you. Please contact the technical team if you need to be trained to use a 1 or 2 star piece of equipment.

- **Can I watch/learn whilst my parts are being made?**

Usually yes, it is encouraged for students to get involved as it helps you learn, and makes things less boring for the technicians. However, if access changes unexpectedly limiting the number of people allowed in the lab at any one time, then this may not be possible. You must make sure to follow any instructions you are given, as the lab has strict safety guidelines you must adhere to.

- **I have my own 3D printer at home, can I print parts and bring them in?**

This is fine, though the advanced Stratasys FDM printers in the lab are likely to produce better results. Please be aware if using your own 3D printer at home, the university cannot re-imburse you for materials used or wear & tear, nor will the University be held liable for any damage or injury occurring from the use of such equipment.

- **I am a pro at machining/I have been inducted in the FET Engineering workshops or somewhere else previously, do I still need to do a BRL induction?**

Everyone who wishes to use BRL equipment must carry out a BRL induction for that piece of equipment, regardless of previous experience, and sign to say they have received this induction training. Anyone who has not signed will not be allowed to use the equipment. This is because it may be significantly different to tools you have used previously, and whilst boring, ensures everyone knows what to expect and is confident when handling dangerous equipment.

- **When can I use the workshops and labs?**

The workshops and labs are only open during normal office hours and closed on evenings and weekends. This is because they may only be used when a member of staff is present or within easy reach, to offer supervision and health & safety guidance.

- **I have a really boring repetitive task to do, can I listen to music/watch video/read a book whilst in the labs?**

Unfortunately, not, as boring as it is, tasks often require your full attention for safety reasons, such that you don't accidentally drill through your hand using the drill press for example. It may also be necessary to attract your attention (such as in the case of an accident or fire) which makes the wearing of headphones unwise.

- **I'm hungry, can I eat my lunch whilst carrying out my lab work?**

No, food and drink are banned in the workshops and labs and anyone found to be doing this will be asked to leave and go and eat somewhere more sensible like the canteen.

5. Ethical approval

Some projects on this unit may require experiments that require ethical approval. If you think this may be the case, make sure to discuss this with your supervisor as soon as possible.

<u>What should I do if my project requires ethical approval?</u>

Projects in this unit should fall into one of three categories:

- This project did not require ethical review as determined by my supervisor.

- This project fits within the scope of the ethics pre-approval process [see Blackboard for document explaining this process in detail].
- An ethics application for this project was reviewed and approved by the faculty ethics committee.

Students must include a statement in the frontmatter of their dissertation, attesting to which category their project falls within.

How does the blanket ethics pre-approval process work?

This unit has blanket ethical approval for "obviously harmless" projects (see the full process document on Blackboard for the definition of obviously harmless). If you think your project fits within this process, please fill out the project experiment form (available on Blackboard) and review it with your supervisor. If your supervisor agrees that the blanket ethics process applies, then simply email the completed form to grp-dissertation_unit_2022@groups.bristol.ac.uk. When you submit your dissertation, make sure to include the following statement in your frontmatter:

"This project fits within the scope of ethics pre-approval process, as reviewed by my supervisor [fill in name] and approved by the faculty ethics committee as application 12723"

Please also include any participant facing information used in your study (i.e consent form and PIS with all fields left blank) as an appendix to the dissertation. Templates for these documents can be found on the dissertation unit Blackboard page.

6. High performance computing

If you want to use University of Bristol's high performance computing (HPC) facility you have to go through following steps:

1. Read the BlueCrystal User Guide and see if you simulation project is suitable for it: https://www.acrc.bris.ac.uk/acrc/pdf/bc-user-guide.pdf
2. Apply for an account. Link to application form (use your University of Bristol login details): https://www.acrc.bris.ac.uk/login-area/apply.cgi
3. On the form, please use the following project code:
   Project: **EMAT028104**
   Title: MSc Robotics

More information on BlueCrystal in general can be found here: https://www.acrc.bris.ac.uk/acrc/resources.htm

7. March scheme

Pass: at least 50 out of 100

Merit: at least 60 out of 100 for the taught component overall and at least 60 out of 100 for the dissertation.

Distinction: at least 70 out of 100 for the taught component overall and at least 70 out of 100 for the dissertation.

A mark of at least 80 out of 100 implies the final report is of publishable standard.

A detailed mark scheme is shown as a table on the following page:

Percentage Mark	< 40%	40 - 49%	50 - 59%	60 - 69%	70 - 79%	80 - 89%	90 - 100%
Overall Descriptor	Very poor	Poor / Inadequate	Adequate	Good	Very Good	Excellent	Outstanding
1. Aims and Objectives (10%) * Identify relevant investigation / research topic * Realistic and challenging aims and objectives identified * Identification of depth and breadth of the project * Level of Technical Difficulty in Investigation (scope)	Aims not specified, scope unclear, no suitable challenges and depth/breadth	Aims barely specified, scope unclear, lack of suitable challenges and depth/breadth	Aims stated but too general or too narrow, scope unclear or inappropriate, challenges lacking depth	Aims stated but quite general or unambitious, some consideration of scope and related challenges	Aims, objectives and scope clearly stated, appropriate and largely addressed, with challenges undertaken and discussed	Challenging aims and objectives clearly stated and addressed; clear and appropriate scope; difficult challenges undertaken and discussed	Challenging aims and objectives clearly stated and fully addressed; clear and appropriate scope; all challenges fully and successfully completed
2. Project Management (5%) * Evidence that student has led their own project (self-direction) * Evidence of project planning and appropriate use of supervision * Adherence to review and meeting dates, and all time constraints * Risk awareness and mitigation * Control of projects - resources, communication, etc.	Little or no evidence	Approach poor, proposal / progress review documents missing, little evidence of use of supervision	Approach adequate; some progress review document missing; some evidence of use of supervision	Approach sound but unimaginative; required documents and further evidence of planning and use of supervision present	Thoughtful approach, required documents and sound evidence of planning and use of supervision present	Approach rigorous and appropriate; required documents and strong evidence of planning and use of supervision present	Approach rigorous and appropriate; evidence of planning, management and use of supervision impeccable; all requirements met
3. Context to the Work (15%) * Background literature review and research (breadth and depth) * Interpretation of previous work in the topic * Critical discussion of relevant published work * If required, suitable contact with outside bodies; e.g. data providers, sponsoring companies, etc. (primary research)	Negligible	Minimal, low level, perhaps entirely reliant on internet sources	Limited, perhaps primarily reliant on material from taught module/units, or muddled approach	Some sound academic content, but unchallenging or not understood	Sound academic content, very good breadth or depth, understood and applied	Very good breadth and depth of academic content, understood and applied	Exceptional breadth and depth of academic content understood and implemented
4. Research Methodology (15%) * Appropriate selection of research methods demonstrating an understanding of alternative approaches * Relevant Breadth * Relevant Technical Depth * Identification, Use and justification of Appropriate Techniques to Gather and Analyse Data * Limitations: Ethical, Environmental, Financial, Time, Policies and Human Resources	Minimal breadth and depth; poor grasp of the techniques used; limited discussion about the wider impact of their work	Inadequate breadth and depth; little or no understanding of the techniques used; no understanding or discussion about the wider impact of their work	Limited breadth and depth; description of the techniques minimal; some understanding or discussion about the wider impact of their work, perhaps confused or unclear	Sensible breadth and depth; description of the techniques unclear; some understanding or discussion about the wider impact of their work, perhaps uninspiring or unconvincing	Good breadth and depth; description of the techniques clear; good understanding and discussion about the wider impact of their work	Very good breadth and depth; detailed description of the techniques and evaluated; well-defined understanding and detailed discussion about the wider impact of their work	Very good breadth and depth; excellent description and evaluation of the techniques used; well-defined understanding and insightful discussion about the wider impact of their work
5. Scientific Method - Technical Content (10%) * Data collection and analysis based on justified methodology * Evaluation and interpretation of discoveries	Little or no analysis or evaluation of content	Content mainly descriptive and analysis weak; no real evaluative content	Content mainly descriptive and analysis confused or superficial	Largely descriptive but with some attempt at analysis and evaluation of evidence	Good range of evidence appropriately analysed and evaluated	Wide range of evidence analysed and evaluated from appropriate perspectives	Wide range of evidence, carefully analysed and critically evaluated; original insights revealed
6. Scientific Argument (15%) * Development and Coherence of Arguments from the literature * Comparative analysis between project findings and literature review * Development and quality of the scientific argument * Evidence of the ability to evaluate information and synthesise conclusions * Critical appraisal of the research methods used * Innovation style: problem solving, or step-by-step learning through established techniques	Structure poor, no real argument discernible	Superficial only, no real argument considered	Some sense of development of ideas, but not well organised	Good structure and flow, but conclusions unconvincing or unsurprising	Very good structure and flow; well argued; conclusions justified	Structure and flow excellent; very clear argument(s); conclusions justified	Structure and flow excellent; very clear and strong argument(s); conclusions justified
7. Evaluation and Accomplishment (20%) * Critical appraisal and evaluation of the project and process * Reflection of self-development whilst conducting the project - reflection of problem solving skills * Achievements and shortcomings of the project in relation to explicit aims and other criteria as appropriate * Relating the project to wider social / industrial implications, such as ethics, environment, finance, etc. * Further research and development * Recommendations	Little or no evidence, missing or minimal critical appraisal	Little awareness of shortcoming of work through critical appraisal	Some awareness of shortcomings of the approach taken or work through critical appraisal	Good, if uncritical, appraisal of both process and final results/product	Thorough critical appraisal of process and product/final results, sound evidence of learning	Achievements, shortcomings and potential further developments all fully appraised	Thorough, insightful appraisal of achievements, shortcomings, and potential further developments
8. Citation (5%) * Accuracy, Consistency and Completeness * Listing of References located at the end of the report or chapters * Possible use of a Bibliography - understanding distinction between referencing and bibliography	No / few citations of source material; source details missing / incomplete	Limited citation of sources; some source details missing / incomplete	Some citation of sources, but some source details missing / incomplete	Most sources cited and listed; some details missing / incomplete	Sources largely cited and listed correctly; errors in style or detail only	All sources correctly cited and listed; errors in style or detail	All sources correctly cited with full details listed
9. Report Presentation (5%) * Logical structure of report and clarity of presentation * Conformity to style and layout requirements * Quality of writing, spelling, grammar, diagrams, figures and tables * Clarity of Expression and use of English * Appropriateness of Style to Audience	Layout poor; grammatical, spelling / punctuation errors throughout	Poorly laid out and let down by poor standard of writing and/or proof-reading	Layout very basic; readability marred by errors in use of English / proof-reading	Reasonably well-written and presented; scope to improve style or proof-reading	Very well-written and presented with only minor errors in typography or style	Very well-written and presented, negligible errors in typography or style	Exceptional style, standard of writing and presentation, may be publishable