

CSC4006 (2018-19)
Research and Development Project
A Staff/Student Handbook

Compiled by
Blesson Varghese PhD, MBCS, FHEA

29 August, 2018

School of Electronics, Electrical Engineering and Computer Science
Queen's University Belfast
Northern Ireland, UK

Contents

1 Module Co-ordinator	3
2 An Overview	3
2.1 Course Background	3
2.2 What is a Research and Development Project?	3
2.3 What you have to submit	4
2.4 Course organisation, timetabling and submissions	4
2.4.1 Advisory sessions	4
2.4.2 Submissions	5
3 The Course Details	5
3.1 Course Contents	5
3.2 Learning Outcomes	5
3.3 Skills	6
3.4 Project Roles	6
3.5 Recommended Time Spent on the Project	6
3.6 Recording Meetings	6
3.7 References (Avoiding Plagiarism)	7
3.8 Original Work	7
3.9 Deadline Extension	8
4 Choice of Projects	8
5 Assessment and Mark Allocation	9
5.1 Assessed Components and Mark Allocation	9
6 Specifications of the Documents to be Submitted	9
6.1 Preliminary Research Article	9
6.2 Research Article	11
6.3 Software Development Report	12
7 Project Showcase	14
8 Project Demo and Presentation	14

1 Module Co-ordinator

Dr Blesson Varghese^a

01.003 Computer Science Building, 18 Malone Road

E-mail: b.varghese@qub.ac.uk; Web: <http://www.blessonv.com>

^aContributions from colleagues and the efforts of Dr Cheng Long and Dr Brian Murphy and their predecessors are acknowledged.

2 An Overview

2.1 Course Background

- CSC4006 is a double module worth 40 CATS points; one of the conditions for the award of a MEng degree in Computer Science is that CSC4006 is passed.
- CSC4006 is a project-based course. Each student is allocated a project and a supervisor; group work is not permitted.
- Marks are allocated for project work submitted on or before the deadlines. To pass this module, a student must obtain an overall score of 40% or above.
- Project work is of special interest to employers and is often discussed during interviews etc. Project work is often cited in academic references.

The course aims to provide the student a rich experience of working within a strong research environment and interacting closely with at least one academic researcher.

2.2 What is a Research and Development Project?

Typically, a Research and Development Project will include two parts:

1. Finding an analytic or algorithmic solution to a research problem;
2. Designing and implementing a computational system to evaluate the solution.

The theories/algorithms/evaluation/results/conclusions developed from the project should be documented in a *Research Article*, and the software system developed from the project should be documented in a *Software Development Report*. The Research Article may be suitable for publication.

Possible research areas include:

- High performance and distributed computing, including Cloud computing
- Data science, knowledge and data engineering, including AI
- Speech, image and vision systems, signal Processing
- Cybersecurity
- Computer games development

2.3 What you have to submit

On completion of the module you are required to deliver three key components (although other interim submissions are required, and are detailed later in this handbook).

1. A Working Project, which should demonstrate your skills in creating an effective software/hardware system as a solution to the problem you have investigated;
2. A Research Article, which is a formal academic document detailing the problem, the original contributions to the problem being studied and academic findings of your research. Originality and a well-written publication for a professional journal or conference are strong indications of a first-class R&D project;
3. A Software Development Report, which is a software developer's document detailing the development of the software system used in your research.

2.4 Course organisation, timetabling and submissions

2.4.1 Advisory sessions

Table 1 indicates the list of advisory sessions for the module.

Time	Date	Location	Session
12:00-13:00	Tue, 25th Sep 2018	Ashby 02.014	Introduction
12:00-13:00	Tue, 23rd Oct 2018	Ashby 02.014	Advisory Session - 'How to formulate a research problem and do a literature review'
12:00-13:00	Tue, 22nd Jan 2019	Ashby 04.006	Advisory Session - 'How to write a research article'

Table 1: List of advisory sessions

2.4.2 Submissions

Table 2 indicate the deadlines for the module.

Deadline	Description
23:59 30th Sep 2018	Selection of 5 projects, in order of preference, to be selected online at https://selfservice.eeecs.qub.ac.uk/projects
23:59 23rd Nov 2018	Preliminary Research Report, to be submitted electronically using Turnitin.
23:59 29th Apr 2019	Research Article and Software Development Report to be submitted electronically using Turnitin. Any software code should be uploaded to Gitlab.
1st May 2019	Project showcase (schedule TBA)
TBC	Presentation slides to be submitted electronically on Queen's Online
TBC	Project demo and presentation (schedule TBA)

Table 2: List of deadlines

“...a deadline should not prevent you from writing, but writing will help prevent you from missing your deadline. Then write a word. Then remind yourself of that again. And then write another and hey, look at you! You're spitting in that deadlines eye.” – Courtney Summers

3 The Course Details

3.1 Course Contents

The project will take the form of a research investigation. A research problem should be investigated by developing a piece of software that can be used to generate research results. The results from the investigation should be analysed and appropriate conclusions drawn.

3.2 Learning Outcomes

Following successful completion students will be able to demonstrate:

1. Knowledge and understanding of a given research problem;
2. The ability to investigate a research problem;
3. The ability to develop a substantial software system;

4. The ability to analyse results;
5. The ability to conduct a survey of the literature;
6. The ability to defend the research presented in an article.

3.3 Skills

The ability to apply investigative skills, research skills and general software engineering principles to the solution of problems - which may require investigative, practical or design skills or a combination of all three.

Originality is encouraged.

3.4 Project Roles

A *student* is responsible for ensuring that the project is carried out effectively and completed satisfactorily on schedule. A student is responsible for submitting the project documents on time and proofreading the documents carefully before submission. It is the responsibility of the student to arrange regular meetings with the supervisor throughout the project.

A *supervisor* is responsible for providing guidance on the project being investigated, to ensure that the student can complete the project in the time available. A supervisor is not responsible for finding solutions to problems encountered when investigating a problem and developing or debugging the program code.

Technical queries should be discussed with the project supervisor. Other more general queries can be discussed with the Module Co-ordinator and/or with the supervisor as appropriate. In addition to face-to-face meetings, students are expected to communicate with their supervisors and if required with the Module Co-ordinator via e-mail.

3.5 Recommended Time Spent on the Project

Students should devote the same proportion of their time to the project as they do to taught modules. Assuming 12 hours per week for one module in one semester, this 2-semester double-module project is allocated 12 hours per week. This project covers the 12 taught weeks in the first semester, the 3 weeks examination period at the end of the first semester, and the 12 taught weeks of the second semester. This gives a total of 27×12 equals approximately 320 hours, including the assessment process which includes presentation and demonstration.

3.6 Recording Meetings

It is a university Masters level requirement that students keep minutes of meetings with their supervisors using a pro-forma which is found on Queens Online. A completed form

should be emailed to your supervisor subsequent to each meeting. This minute should contain a brief summary of the meeting, the matters discussed and any action agreed between you and the supervisor and should be emailed to the supervisor before the next meeting. Each form should be signed by both parties as a true record. The completed forms should be appended to the research article.

3.7 References (Avoiding Plagiarism)

You must always distinguish your own ideas, views, comments and contributions in the project from those of the others. To do so requires the high level of intellectual honesty which is expected from you and your peers. When you use other researchers' work, thoughts or ideas in helping your own work you are obliged to reference the original work. This includes condensing and rephrasing other authors' work in your own words. Code taken from the internet (or elsewhere) must be explicitly acknowledged. This includes the code taken from your supervisor.

Note: All reports will be submitted via Turnitin to detect plagiarism.

3.8 Original Work

Nowadays, almost every technical advance is built upon some previous work in the same or a different discipline. You will only be given credit for the part of the work that's created by you which is original to the project¹.

For many students on the MEng pathway, conducting research into an ill-understood problem and writing a research article is a challenging experience. You will receive help from your supervisors, but research is largely an independent, self-directed process. In the other modules of the course you have been set targets and objectives through the coursework assignments and deadlines but in this phase of the course, you will need to set your own deadlines, and manage the experience. You will need perseverance, endurance and determination. Initially this can seem intimidating, but it is also an opportunity for you to learn and grow.

The Research and Development Project is designed to be a learning experience and it is highly likely that you will extend your existing knowledge and skills and that you

¹Material supplied at the outset or during the project may be the subject of copyright (or other industrial property rights) and other such material may be created during the project. It is in order to make use of this material purely for educational purposes associated with the project. No attempt must be made to exploit any of the project material commercially by communicating it to organisations or individuals outside the University or otherwise. In general, the policy is that any potentially valuable results, whether patentable or not, obtained during the course of a project which was carried out during the course, should be exploited for the benefit of the public, the University, the student and the supervisor, but subject to any regulations laid down by a grant awarding body or the University. Thus, if it appears to the University that a project might be suitable for development and commercial exploitation, it will initiate steps to this end. Students who have been involved in such projects will be informed and may be required to co-operate in the exercise. In the event of any project producing a net profit to the University, ex gratia payments to individuals will be made in accordance with University custom and practice.

will gain some new knowledge and skills. Writing at the Masters level and developing a research software system are specialised skills, which will develop your intellectual, critical and problem-solving capabilities. The research article and the software development report are the academic work which marks the transition between being a student and a researcher (who is more than just a software developer). Writing an article and a report will enable you to develop valuable technical writing skills.

Regardless of the career path you have chosen, the process of thinking creatively and analytically, assembling a well-reasoned software/hardware solution, writing/publishing at professional level and managing your time will all serve you well in the future.

3.9 Deadline Extension

Deadline extensions are not normally granted. In some circumstances, such as the submission of an exceptional circumstances claim, the supervisor may grant an extension.

Any extension longer than five days will result in a late graduation as the assessment of the project cannot be completed in time for the Examination Board meeting.

4 Choice of Projects

At the beginning of the module, a list of available research topics will be provided. Each student is required to carefully study the supplied project options, and then to rank their preferred topics for project allocation. The choices must be provided on <https://selfservice.eeecs.qub.ac.uk/projects> by the given deadline to facilitate the project allocation. Without receiving your preferences by the deadline, you will be assigned a project randomly from the available projects.

In stating your project preferences, you should consider among other things the topics that excite you, the knowledge/skills you would like to develop through the project, the experience you would like to gain, and the usefulness of your project in discussing it with your potential employers. You should also aim to match your ability to the project, to maximise your potential achievement.

If you would like to find out more about a project area for making your decision, please contact directly the specific supervisor(s) who set up the project.

While we will do our best to accommodate each student's choice, we ask your understanding in the limited resources and supervisors available in the School. Should there

be conflicts in the selection of projects, the students with higher course averages will have priority.

5 Assessment and Mark Allocation

Each project is assessed independently by the supervisor and a 2nd assessor, for four different components (see details below). For each component (except the preliminary research article which is assessed exclusively by the supervisor), the supervisor and the assessor will assign an agreed mark which will be returned to the student as the final mark.

Should there be a significant degree of disagreement between the supervisor and assessor on the marks of the work, a 3rd and independent assessor will be sought to mark the work and to draw a conclusion.

5.1 Assessed Components and Mark Allocation

- Preliminary Research Article - 15%* (marked only by supervisor)
- Final Research Article - 55%*
- Software Development Report - 20%*
- Project Demo and Presentation - 10%

* 5% will be deducted for each day a submission is late without prior permission.

6 Specifications of the Documents to be Submitted

6.1 Preliminary Research Article

Use template provided, worth 15%

Please adapt the section titles to suit your specific project, but do not alter the template (style, fonts etc). Use of Latex/Word is acceptable. Submission should be in PDF format.

The Preliminary Research Article **should include** the following: Title, Author Name and Affiliation, Abstract, Keywords, Introduction, Literature Review, References, and an Appendix.

Title – a preliminary title for the research in no more than 10 words.

Author Name and Affiliation – the name of the author and affiliation, including their e-mail address.

Abstract – in no more than 225 words a brief summary of the problem to be studied,

the objectives of the study, the proposed methodology, and the expected results or achievements.

Keywords – list up to a maximum of 5 keywords that captures the research.

Introduction – in no more than 1 page of text with no sub-headings introduce the area of research, the problem being investigated including how its positions within the area of research, and the aim of your research.

You may still be in the early stages of developing an approach (may be a technique/methodology/algorithm) to solve the problem, but also include (i) a potential approach that will be adopted to solve the problem, (ii) the merits/novelty of the proposed approach in contrast to existing approaches, (iii) a brief note on the research software that will be developed to realise the approach, and (iv) a potential set of experiments, and (v) what results are expected.

Literature Review – in no more than 1 page of text include a systematic literature review of research articles. You need to make sure with your supervisor that the articles you are reviewing are worthy of referencing in an MEng project.

For each article considered in the review you may consider: (i) the approaches used by other researchers to solve the problem, (ii) the merit and weakness of the approaches, and (iii) any identified gaps, and (iv) how will your approach be different from existing approaches and how it will bridge any identified gap.

Note: You may use figures and/or tables in the Introduction and Literature Review sections, but must **not** exceed the page limits.

References – is a complete list of the articles or other information sources that have been cited/used in this article, giving the publication details for each reference (e.g., title of the paper, name of the journal or conference, time/location it is published, volume/issue numbers, page numbers, name of the publisher, etc.). Unless you are solving an age old problem, please aim to reference recent papers.

Note: Wikipedia and similar are not acceptable sources to reference. Keep the use of web pages to a minimum, use only when necessary.

Recommended method for referencing is the Institute for Electrical and Electronics Engineers (IEEE) format - “*IEEE citation style includes in-text citations, numbered in square brackets, which refer to the full citation listed in the reference list at the end of the paper. The reference list is organized numerically, not alphabetically*”.

Referencing example:

- [1] H. Xiu, B. Boris and L. Andor, “A 100 Ways to Write a Research Paper,” Journal of Higher Education, Vol. 38, No. 2, 2015, pp. 115-126.
- [2] B. Lamb, N. Norris and S. Subramanian, “Can’t Wait to Finish My Research Project,” Proceedings of the 9th International Conference on Happiness and Joy, 2018, pp. 12-24.

Appendix – In no more than 500 words the appendix will summarise the progress of the research work undertaken, what has been accomplished and how it contributes towards the goals of the project, any preliminary software that has been developed to test ideas, and any preliminary results obtained. This content will evolve into more substantial and multiple technical sections in the research article.

Any preliminary software code developed should be uploaded to Gitlab: <https://gitlab.eeecs.qub.ac.uk/>; the student must provide access to the supervisor.

Note: The supervisor will provide feedback on the preliminary article. The Literature Review section and the progress of work highlighted in the Appendix will contribute towards the mark.

6.2 Research Article

Maximum 15 pages in template provided, worth 55%

Please adapt the section titles to suit your specific project. For example, you could call your Literature Review section as Related Work. Do **not** alter the template (style, fonts etc). Page limit is absolute. Use of Latex/Word is acceptable. Submission should be in PDF format.

A Research Article is a formal scientific/technical document providing a concise account of a research finding. The article should be precise and scientific in nature. At the very basic level, spelling should be correct, sentences grammatical, and formulae, figures and tables clear and accurate. As is usual in academic/technical writing, do not describe things in the first person (say what was done, rather than ‘I’ did it). A good article is always determined by its quality rather than length.

Because different projects address different problems, it is not possible to define a writing structure that applies to all articles. However, an engineering or scientific article and to fulfill the requirements of the MEng degree program will need to contain the following components:

- *Title* – a title for the article in no more than 10 words.
- *Author Name and Affiliation* – similar to Preliminary Research Article.

- *Abstract* – adapted from Preliminary Research Article.
- *Keywords* – list up to a maximum of 5 keywords that captures the research.
- *Introduction* – adapted from Preliminary Research Article.
- *Literature Review* – adapted from the Preliminary Research Article.
- *Appropriate Technical Sections* should provide details of the approaches or methods that are used in the project to investigate the problem, including, for example, the theories, algorithms, investigative procedures or a combination. If the student makes any original contribution to the research into the problem this should be emphasised clearly in this section.
- *Results and Analysis* in which the results of the investigation should be presented in detail. It is important that the exact conditions under which experiments were conducted are documented. The significance of the results should be critically analysed ideally through comparing with existing systems or results. Graphs and tables are encouraged.
- *Conclusions* should include a summary of the project work and findings arising from the investigation. Finish this section by highlighting the limitations of your work and making recommendations on how the work can be further extended.
- *Acknowledgements* – if appropriate acknowledge any support (funding, comments from colleagues etc).
- *References* – up to a maximum of 35 references for the entire article. Guidelines are similar to the Preliminary Reference Article.
- *Appendices (optional, and is included within the maximum page limit)* – should include other information which is not convenient or is disturbing to be included in the main body of the article (e.g. a proof of a mathematical formula that is used in the research etc.).

Note: Take sufficient advice from your supervisor in making sure that your Research Article meets acceptable standards.

6.3 Software Development Report

Maximum 20 pages excluding any title page, single column 1.5 line space, font-size 11pt, worth 20%

There is no standard template for this report, but please follow the guideline provided. Page limit is absolute. Use of Latex/Word or equivalent is acceptable. Submission should be in PDF format.

Software development in a research project may be described in the following sections.

But note that each project will have a different emphasis; some projects may involve only some of the sections below. Understanding what must be defined at each section is an important part of the course. The student's supervisor will provide additional advice on this where required. The project is a means of utilising the skills and knowledge you have acquired from the modules that you have studied (as well as, possibly, your professional experience).

- *System specification:* You should provide a precise description of the software system that you intend to develop. You should list any assumptions that you make about the problem and list any system constraints. A specification may include:
 - A precise data model
 - A complete set of function definitions
 - Details of error conditions
- *Design:* This section should describe the design of your proposed software system. This should normally have two parts:
 - User Interface Design.
 - Software System Design.

Some systems may be compositions of components; the role of each component and the interfaces between components should be described. There should be a clear correlation between your design and your specification.

- *Implementation and testing:* You should describe any languages, packages, and libraries etc. that are used in the development of your system. There is no need to describe your code in detail. You may highlight implementation techniques that are of special interest. If appropriate you may provide:
 - A description of any important functions and algorithms and their implementation.
 - A description of how each component is implemented.
 - Details of test strategies and test suites.
 - A description of integration tests.

The complete program code developed during the research project should be uploaded to Gitlab: <https://gitlab.eecs.qub.ac.uk/>; the student must provide access to both the supervisor and the assessor. The program code must be appropriately annotated with comments and each component should have a complete module header. Programs should be written in a clear style with good program structure and well-defined data structures. The program code should reflect its design.

7 Project Showcase

A project showcase event will be hosted on Wednesday, 1st May 2019. You will demonstrate your project to companies and visitors attending the event. Information for the event will be provided in the second semester.

The demonstration during the showcase will not be marked. This is an opportunity to (i) meet potential employers and impress them with your project, and (ii) obtain experience of a dry run before the marked Project Demo and Presentation session discussed in the next section.

8 Project Demo and Presentation

Demo and Presentation (worth 10%)

At the end of the project, each student is required to (i) demonstrate their project, and (ii) provide an oral presentation of the completed project both to the supervisor and assessor in the same session.

Each student will be allocated a 40 minute session for demonstrating and presenting their work. The date will be confirmed in the second semester. The sessions will be allocated in the second semester. The demo and presentation should last no longer than 20 minutes, which will be followed by a question and answer session.

The oral presentation should be submitted as PowerPoint slides or in PDF format.

The student should demonstrate the system developed from the project to the supervisor and assessor, and answer further questions to the extent to which the completed system meets the original research objectives. If a system is incomplete but partially demonstrable then the supervisor and assessor may award marks only for that portion of the system.

The assessment criteria will be based on:

- The presentation style, including keeping time
- The work that has been demonstrated and done for the research project
- The responses to technical queries

The student may decide how they utilise the 20 minutes allocated for the demo and presentation. For example, consider a project in which the student developed algorithms for scheduling applications in the Cloud. The student is likely to have performed a thorough evaluation of these algorithms. In this case, the student could utilise more time to explain the algorithm and present their evaluation and results instead of demonstrating the execution of the algorithm.

Note: Please take early advice from your supervisor on the best way to utilise the 20 minute session for demo and presentation.