ELEC S402/S403/S404

香港都會大學
科技學院
Hong Kong Metropolitan University
School of Science and Technology

Engineering Project Course

COURSE GUIDE

Autumn 2022 Presentation

Important dates:

Mid-Sep:	Project Briefing Seminar Project selection
Mid-Nov:	Assignment 1 due date
Mid-Jan:	Assignment 2 due date
The latter half of Feb:	Assignment 3 (oral presentation)
Last tutorial:	Project demonstration
Early May:	Assignment 4 (final report) due date

This document should be read as soon as you receive it and frequently referred to during work on your project. It may be supplemented as appropriate in any one year by *Stop Presses*.

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Introduction

ELECS402/S403/S404 is unlike most other HKMU courses in that you will not be swamped with literature. Some students find this rather disquieting, so you must plan your project carefully if time and resources are not to be wasted.

ELECS402/S403/S404 is a fourth-level project and is regarded as a pinnacle of learning how to integrate the concepts you have learnt in the past and apply them to a real problem. Your Honours degree classification will depend in part upon what you achieve. Professional institutions will independently look at your project if you decide to apply for chartered status.

This booklet aims to provide you with advice on how to go about the various stages of doing a project and also includes information on the formal system devised by HKMU to 'run' projects. You will appreciate that because of the very wide scope of topics that can be covered each year, the course team can only provide general notes on how to go about project work.

The *ELECS402/S403/S404* student community each year is expected to be small (of the order of 8 to 12 people). Rather than being one of a large number, you will be known personally to at least one HKMU academic (the Internal Examiner) as well as to your tutor. You will probably meet both of these at one of the occasional meetings. This feature has a lot in common with conventional universities, where final-year students often work alongside individual academics. Some might be overawed by this attention, but this is a unique learning situation, where the enthusiasm brought to the task strongly influences the benefit derived from the support offered. Indeed, academics keep themselves intellectually alive by learning from each other.

It is hoped therefore that you do not see *ELECS402/S403/S404* as just another course, but as a stepping stone from your undergraduate life. It is a cliché, but worth repeating, that an undergraduate honours degree is the starting point of advanced study rather than the finish. However, you view it, make your *ELECS402/S403/S404* project something you value personally.

AIMS

The main aims of the Project Course may be summarized as follows:

1 To provide an opportunity for you to draw together and integrate the knowledge you have gained and skills you have developed in other HKMU courses.

2 To give you the opportunity for independent study, and to develop an ability to organize work with a view to achieving a clearly specified goal.

3 To develop skills in design, or in a similar integrative activity appropriate to technology, and in the presentation of an account of the work in written and oral form.

4 To undertake an academic project based on sound technological principles and intellectual reasoning. (That is, it is not just a descriptive technical report).

1. The Timetable

The timetable for your study on the Project Course is printed separately. However, guidelines for the stages of the project are given in Section 2 of this booklet.

Notice that there are several fixed points in the timetable. These meetings and deadlines are to assist you in pacing your work and to enable your tutor to watch your progress throughout the year. It is in your interests to submit the Initial, Interim, and Final Reports in time, and to attend the associated tutorials and presentation where arranged.

The submission schedules of Assignments must be adhered to. *You must meet the due date for submission of your Final Report*, because the Final Report has to be read and assessed by your tutor, internal and external examiners, within a very tight schedule.

2. The Study Programme

The first formal meeting with your tutor **may** take place before you are officially registered to do *ELECS402/S403/S404*. This meeting is the start of the course and at it, you will discuss your proposal in detail and consider how it will be tackled. Whether the topic is your own or one offered by HKMU, your tutor will wish to outline the broad strategy, assess your strengths and weaknesses, and agree to a preliminary literature survey and reading list. In general, projects for the *Project Course* are expected to include both an investigative component and a design or integrative element.

You may also determine how future contacts should be made, by telephone, letter, or tutorial. At present, the most convenient way to communicate would be through email. This could well be the primary mode of contact. However, in many instances, the problem you have may need a thorough discussion over the telephone, or if it is not too urgent, you may wait for the tutorial. Since there are a limited number of tutorials where you meet face-to-face with your tutor, please make use of the opportunity. As we have seen in the past, students who do not come to the tutorial in *ELECS402/S403/S404* did not perform well in the project.

A fortnight or so after your registration, you should be well underway with searching the literature and preparing work outlines, such as surveys or experiments, for an **Initial Report** around the 8th week. During this period you can expect tutorial help specifically directed to this kind of preparation. After marking your initial report, your tutor will normally hold another tutorial, using your proposals to develop a strategy for the main project effort.

The major work of your project takes place after your initial report has been read by your tutor. During this long period, you may expect tutor support by any of the routes mentioned above, depending on circumstances. You will also be required to submit an **Interim Report** around the 18th week. This report is assessed and will usually be followed by a tutorial to point you in the right direction for the final run. The report should show that you have completed a substantial part of the work so that your tutor can offer advice before you begin to write the **Final Report** (due for submission around the 33rd week). Specific details of the requirements for each report are given in Section 6.

After you have submitted your Interim Report, there will be an opportunity for you to present your work to your fellow students, tutors, and internal examiners. The presentation is part of the continuous assessment. It is also an opportunity for the internal examiners to make suggestions for your project and to make sure you are on the right track.

It is strongly recommended that you keep a *project diary* during the year. At the very least this should be checked against your weekly objectives and should contain details of what you have learnt and the time you have taken. Some tutors may ask students to submit a monthly summary based on the diary. These are not assessed, but give the tutor and student a very good idea of what is happening. You should seriously consider including this approach in your study plan. You will find this useful when you come to write your Final Report, and it could come in handy at the oral examination when the internal examiner is asking questions about the progress of the project. It is of course valueless unless you keep an honest week-by-week record of what you do.

3. Level, Scope, and Commitment

These are three common aspects of *ELECS402/S403/S404* questioned by students and you will probably have sought answers from your tutor right at the start. *ELECS402/S403/S404*, by its designation, is a *fourth-level* course. Generally, you will have undertaken the middle and higher-level courses underpinning your project, and you will be well acquainted with the concepts and principles to be taught therein. You will also be familiar with the level of modelling required. The fourth level designation comes about since you now have to *apply* the modelling, concepts, and principles at this level to your particular problem. You will have to go further in fleshing out the necessary background: hence the importance we attach to background reading and the literature search. However, your project is not for a research degree, and so *you should not be trying to push back the frontiers of knowledge*.

Addressing the question of the scope of your project, there are dangers in having project aims that are either too focused or too wide. To some extent, you should adjust your aims within the context of the level of work expected and the time available. It is preferable to constrain the scope so that the project can be completed without leaving a large number of questions unanswered. However, if this can only be done at the cost of trivializing the problem, you will have to reassess your aims. No one expects you to define these perfectly at the beginning of your project, which is why we ask you to reiterate your aims and objectives in both the initial and interim reports.

Commitment can be divided into time and attitude components. The study time is expected to be 600 hours, but because of the stop-start nature of the project work, you will inevitably take more time than this, especially if you have to go out and about to see people. People also work at different rates, and by now you will have a pretty good idea of whether you are a fast, slow or average person in HKMU terms.

The question of attitude is also extremely important. A few students regard *ELECS402/S403/S404* as a simple option and fail to take it seriously enough. Inevitably their poor performance is a disappointment to both themselves and their tutor. This is an honours level course and should be treated as such.

There are ups and downs in all project work, and you will inevitably discover some dead ends. These can be very demoralizing, but coping with them constructively is an important aspect. One reason for having a good project framework is that you can tackle other areas if one area appears to dry up. If you do appear to be on the wrong track, make sure you contact your tutor without delay.

An *ELECS402/S403/S404* project is academic in nature. It is to do with learning, choices, sifting of evidence, and backing conclusions based on fundamental concepts. It should not be confused with a business or technical report such as you might write for your place of employment.

4. Your Support System and the Internet

You are by now quite familiar with the regular mailings, broadcasts, and continuous assessment of other undergraduate courses. The *Project Course* has no course units, no broadcasts, and very little supplementary material. (At least you may expect fewer errata sheets and lost mailings!) Nevertheless, you may still need to consult your counsellor about any difficulties that emerge from your reading of the *ELECS402/S403/S404 Study Guidelines* or about problems with your tutor.

In the Project Course, the programme of study is largely in your own hands. HKMU's obligation is twofold:

- to give you the best possible support;
- to see that your work is properly assessed.

It is impossible to separate support from assessment because your tutor and HKMU are interested in both.

Normally each project tutor will supervise five to seven students. Your tutor will be your immediate point of contact for all academic problems. He or she will decide whether to call in the help of the internal examiner.

After receiving your Initial and Interim Reports, your project tutor is asked to submit short progress reports to your Internal Examiner. This will alert us to failings arising from a lack of facilities or other weaknesses.

Your Internal Examiner is normally a full-time academic staff of the School of Science and Technology, HKMU who reads and assesses the Final Report and, along with your project tutor. Your Internal Examiner is thus also involved in monitoring your reports. It is likely that your Internal Examiner will make comments to your Tutor after each report and that these comments will be communicated to you.

The Award Committee consists of your internal and external examiners and a chairman. Based on the scores given by tutors and internal and external examiners, the Award Committee is responsible for deciding the final result status of each student.

4.1 The Internet

Like other HKMU courses, we will make use of the Internet and the World Wide Web as a means of communication and support for your studies. The use of the Internet is compulsory, and we strongly encourage *ELECS402/S403/S404* students to get access to these electronic facilities.

We will use the University's OLE. In particular, the assignment record and extension system will be there to enable students to see the progress of the assignment marking.

5. Assessment

The assessment of the project will be based on the following components and weightings:

(a)	Initial report (Assignment 1)	(10 percent)
(b)	Interim report (Assignment 2)	(20 percent)

(c) Oral presentation (Assignment 3) after the interim report (10 percent)

(d) Final project report (Assignment 4) (60 percent)

The responsibility for assessment of these components will be:

- Initial and interim report, oral presentation: tutor and internal examiner
- Final project report: tutor, internal and external examiners
- Oral Examination (if required): internal and external examiners in consultation with your tutor.

To gain at least a credit you will have to:

(a) gain at least 40% overall

(b) gain at least 40% for the Final Report

(c) gain at least 40% for the cumulative score of the initial report, interim report, and oral presentation.

Result status will be awarded following the HKMU system, except that the continuous assessment thresholds for all the pass statuses will be 40.

All marks contribute to the course score of *ELECS402/S403/S404*. The final report score will form the overall examination score.

6. Initial and Interim Reports

Please note that your tutor will only give marks for what is contained in your reports, and not for work he or she may know you have done but which is not included in the reports. Tutors are instructed to reserve a proportion of the total marks available for reports that demonstrate a level of scholarship and authority in their approach that is appropriate to an honours level course. This does *not* mean that you should be undertaking original research, but that you should have shown a thorough grasp of the basic principles involved and shown that you can handle the material authoritatively and originally.

You should treat the details given below, on the content and style, as guidelines for the *majority* of reports. There are instances where a completely different approach is taken (for example, in some systems and design projects). In those cases, consult with your tutor before submitting your reports, to check that, whatever approach you are taking, you are reaching the required level and scope.

6.1 The initial report

(The percentage given alongside each section indicates the approximate weighting of marks given.) Your initial report, which should be typed, will usually be presented under three main headings:

1 Project Definition (20 percent)

It should include:

(a) *Project objective*: the 'what' of the project: a statement of what is to be achieved, the expected outcome, and possible use or value of the project. In experimental studies, this could be represented by the hypothesis that is to be tested.

(b) *Overall objective*: the 'why' of the project: why you consider it important and worthwhile. Merely 'because it's there,' or 'data collection for its own sake,' confounding your predictions.

(c) *Proposed approach and method to be employed*: the 'how' of the project: a statement of how the objective is to be achieved.

2 Investigation of Project Background (60 percent)

This should be a *critical* appraisal of any background literature you have found to be important in formulating and developing your project. It should also relate the topic clearly to existing similar work, where appropriate, and build on concepts and principles you have learnt in other HKMU courses. This section is allocated the most marks, reflecting the importance that this aspect will represent in your Final Report.

3 Project Plan (20 percent)

This should include a diagram (a chart or schedule), matching the specific tasks to be completed in your project against the time available. You should also consider the resources required for the successful completion of the project (e.g. information or access to equipment and facilities). Be as specific as possible and state the position regarding agreements that have been reached about the use of facilities, etc.

This report should be about 2000 words long. Your tutor's comments written on the report will be reinforced in the subsequent tutorial.

Your tutor will be looking for the following:

a) references studied, with comments as to their relevance;

b) your understanding of the basic principles underlying the project;

c) identification of a definite topic and relation to existing similar work;

d) specification of the goals of the project;

e) outline of a strategy for achieving these goals.

Throughout the report, your tutor will be looking for a 'critical and analytical approach to the problem being investigated. Be careful that in your enthusiasm you do not lose sight of the aims of *ELECS402/S403/S404* and the objectives of your project.

You must include as much detail as possible in your initial report, to enable your tutor to give you guidance and advice. It may be that as a result of the submission of this initial report you will have to revise the aims and methodology of your project, and in this respect, it is crucial to consider your tutor's advice very carefully.

6.2 The interim report

This report which should be typed should be presented under three main headings:

1 Progress since the initial report (25 percent)

This section should contain a brief statement of the following elements:

a) A restatement of the project objective: has the objective changed or been developed since the initial report? If it has not changed or developed, state why it has stayed the same.

b) Your progress: a statement of what has been achieved since the initial report.

c) Problems and successes: a comment on the successes of the project so far and/or any practical problems that have arisen and how they were tackled.

d) A critical assessment of any further literature you have read, or a reinterpretation of some of the material you presented in the first report, in the light of further experience.

e) Project plan: a summary or diagram of tasks to be completed in the remaining time.

2 Draft chapter (50 percent)

The draft chapter should be about the method or methods of investigation you are using in your project. It should include, where appropriate, the theoretical background of the project. You should also include a brief discussion of how the project could have been tackled when you were first considering doing it. This should then lead on to a description of the strategy you decided to adopt and the reasons why this one was chosen. Finally, you should interpret your findings in light of the literature you have studied to date.

Treat this as though it were a chapter in your Final Report, so make sure you read the notes on style and presentation in Sections 8, 9, and 10.

3 Report structure (25 percent)

This section should include a list of chapter headings for your Final Report, with a brief synopsis outlining the likely content of each section. You should also include an approximate word or page count for each chapter.

This report should be about 3000-4000 words overall.

6.3 Administration of initial and interim reports

For administrative purposes, the 'assignment numbers' of the initial and interim reports are:

Initial Report	Assignment	1
Interim Report	Assignment	2
Oral Presentation	Assignment	3

The due dates for submission of these reports are shown on the separate timetable.

Completing your reports

Use A4 size paper and put your name, your student number, and the appropriate assignment number at the top of every sheet.

Sending in your reports via E-submission

When you have completed each report, you should submit a **pdf copy** of your assignment via the **e-submission** functions in OLE.

Remember that the due date is the last date by which your assignment is submitted via the e-submission in OLE.

7. *Final Report*

Your Final Report is marked by your tutor and the internal examiners. Your Final Report may also send to the External examiner for monitoring.

7.1 The Final Report

The Final Report is the most important element in the course and accounts for *60% of the total* marks available. Your tutor and the internal examiner mark your report.

Recommended marking schedule (Internal examiners may slightly vary this outline, as appropriate to different projects)

1 A critical analysis and explanation of the project and clarification of its aims. *(20 percent)*

2 Integration of technological understanding in achieving the aims of the project. *(25 percent)*

3 Independent reading and study, and critical use of literature in discussing the findings of the project. *(25 percent)*

4 Organisation of work and component activities of the project. *(10 percent)*

5 Clarity of presentation of the report. *(20 percent)*

Total **(100 percent)**

The formal requirements of the *Project Course* allow for flexibility; normally the average length of a Final Report would be between 10000 and 15000 words. Consult your tutor if you think you may seriously overrun the word count. It may be that you are including unnecessary material or could organize the structure in a better way.

It is important that as well as your successes you record your failures; that is, the dead ends or false trails. Explain the reasons for the failures and why they were not predicted. One of the aims of the course is to *teach you how to do a project.* Some students may not reach a 'successful' outcome such as a solution to the problem or a working model. They may nevertheless have learned just as much as, if not more than, those who do. Unless you record the whole progress of your project, the examiners will be unable to tell what you have learned.

Confidential material

The Award Committee cannot accept a Final Report that contains confidential material. The reason for this is that all Final Reports **will** be kept in the HKMU Project Lab and may be available for reference by others. This is normal practice and happens with undergraduate and graduate project reports in other universities. To avoid any complications please ensure that your sources of information are not confidential. If you are in any doubt, please contact your tutor.

Acknowledgments in Final Report

You are required to specify and acknowledge the kind of support you may have received from your employers in your project work by completing the form *Statement of Assistance Given by the Employer* sent to you and binding it in the front of the Final Report.

At the beginning of your Final Report, you should also acknowledge help or assistance from any other source.

Submission of your report via E-submission

When you have completed Final Report, you should submit a pdf copy of your report via the e-submission functions in OLE.

Remember to allow plenty of time for typing, so that you have time to make corrections and final amendments. Note: **no reports can be accepted after the due date**.

Completing your report

Please make sure that your name, student number, project title, and project reference number are included. Please DO NOT include copyrighted materials from another party (e.g. manufacturer's manual).

7.2 The project demonstration

You should perform a **demonstration** of your project during the **final tutorial** of the course. Your tutor and the internal examiner will attend the demonstration. We will also take a 5-minute video of your demonstration for the external examiner's reference. The purpose of the demonstration is to enable the examiners and tutor to ascertain your accomplishments in the project. This may assist them in the assessment of the final report.

7.3 The oral examination

There will be no compulsory oral examination in this project course. Where the internal and/or external examiner(s) feel the necessity of having an oral examination for a certain student, that student will be informed accordingly to appear for the oral.

The aims of the oral examination

- To provide an opportunity for you to demonstrate your understanding of your project and to compensate by verbal communication, when necessary and possible, for a poorly written presentation.
- To provide an opportunity for the examiners to satisfy themselves about the level and amount of work done, by allowing you ample opportunity to give a detailed account of the project.

The oral examination

The internal and external examiners will ask most of the questions. You will probably have become acquainted during the year, but even if not, there is no need to feel overawed by the situation. The examiners will want to check your knowledge of the background of the project and its underlying principles and look at some of the details of how you tackled your project. Likely, the examiners will also ask some further questions arising from your findings. Such questions are open-ended and will allow you to demonstrate your overall grasp of the topic. The examiners will not be seeking to trip you up or embarrass you and are in general trying to give you opportunities to demonstrate your command of the topic.

8. Some Notes On Style, Presentation, and Data Handling

This section is intended as a guide to help you in writing your Final Report. Within the *Electronic Project Course,* there will be significant differences between, say, a technical and a systems report.

We do not wish to prescribe your style, but merely to affirm that a good piece of writing is easily recognised, being noteworthy, among other things, for its clarity, conciseness, and orderly presentation. Above all, remember that your report should be addressed to a general but informed reader, and written so that someone else could, if necessary, continue with the work.

Visual presentation

Appearance is important, though, of course, it must always remain a matter of taste.

- Use A4 size paper and leave at least 30mm for the left-hand margin and about 25mm for the right-hand margin. Also leave about 25mm at the top and 25mm at the bottom of each sheet, especially if your report is going to be photocopied.
- Ensure that if you work in SI units you use the correct symbols and their prefixes. The same applies to mathematical symbols. Remember that few keyboards have Greek letters so you may have to write these in by hand: use black ink. You should check the typescript of your report for omissions of this kind before submitting it
- Number each sheet at the top. Make cross-references by section rather than by page, because page numbers may change later.
- Chapters, sections, and subsections should be numbered for references, but avoid ugly sub-sub-section numbering such as 4.2.3.6. Mixed labelling can be useful, for instance, 4.2 (c) (vi). However, such detailed labelling is only necessary for a closely argued or legalistic document, such as an industrial tender for a contract. To keep the contents list short, include only numbered headings. There is probably no need to exceed two numbers here, such as 4.2 or 3.4.
- Headings should be used at the beginning of chapters, and wherever necessary elsewhere, to point the way or avoid confusion. They should be underlined, or distinguished by a change of size or typeface in word-processed documents.

Information formats

- Tables should be used to present information concisely where graphs or histograms are not appropriate. In setting out tables, arrange the data so that there are more rows than columns and use a minimum of horizontal lines.

Table headings should be by chapter (e.g. 1.1, 1.2, 1.3 ...) in the order in which they are mentioned in each chapter (Chapter 1 in the examples quoted). They can then be referred to in the text by number only (e.g. Table 1.1). Typed tables should be on separate sheets since this will save time if any are deleted or altered.

Where you use a large number of tables they may be collected at the end of the report; but if you use only a few, place them in the typescript near to where they are first referred to in detail.

- Equations should be numbered only when they are to be referred to later or taken as a result of later mathematics. Numbering them by section (e.g. 2.3, 2.7) ensures that if one is deleted or you need to refer to an equation you have not previously numbered, only those in that section need to be renumbered. Keep the number to the right, well away from the equations, and check all references to equations when reading your final draft.

- Graphs, histograms, drawings, diagrams, and photographs should all be referred to as figures: Figure 1.1, Figure 1.2, and so on.

  If they are small you may get two on a page, but again it is best if they are set out on separate sheets, each with a typed figure caption. Either place the figures in the text next to where they are first needed or, if there are a large number of them, collect them together at the end of your report.

  You will have to annotate figures yourself, so keep labelling to a minimum, by use of letters, recognizable abbreviations, and conventional symbols. Use the figure caption for explanations of detail. For example, some curves on a graph may be labelled A, B, C and then identified in the caption. Accuracy is essential.

- Use black ink to draw and label figures, as these make photocopies best. Do not use colour to differentiate between curves or parts of a diagram, unless you are prepared to colour three copies individually, since colours reproduce as shades of grey.

  If you use photographs, try to obtain three prints, since photographs again do not photocopy well.

  Check all references to figures and any information you quote within the details of the figure.

Use of references

- Reference should be given in the text to any previous work from which you have quoted results, taken tables or reproduced figures, or which you have used for relevant background information

- You can either use a numbered reference such as Jones[1] (or Jones[1.1] if you give references section by section) or refer to the author(s) by name and give the year of publication; for example, 'Jones and Brown (1978)' or ' ... it was found (Jones and Brown 1978)'.

- Where there are more than two authors, use 'et al.' in the text; thus: 'Jones et al. (1978)'

- When the author(s) has more than one publication in the same year use a, b, c, etc. (see example below).

- At the end of your report give a list of references, either in numerical order if you used numbered references, or in alphabetical order of first authors :

Haughton, P.M. (1977) 'Physics and the ear: an outline of the mechanisms of hearing,' *Physics Education*, vol. 12, July, pp313-17.

Hope, A. (1978a) 'Video recording: the battle behind the scenes, *New Scientist*, vol. 78, no. 1097 (6 April), pp8-10.

Hope, A (1978b) '100 years of microphones', *New Scientist*, vol. 78, no 1102 (11 May), pp378-79.

Surrey, A.J., & Bromley, A.J. (1973) 'Energy resources', in Cole, H.S.H. et al. (eds) *Thinking about the future*, Chatto and Windus/Sussex University Press, pp90-107, Brighton.

Taylor, R. (1970) *Noise*, Penguin, London.

Walters, A.P. (1976) Piano Mechanics, University of Nottingham, BSc Project Report (unpublished).

- The main point to consider in giving a reference list is that the work should be easily identifiable if the reader wishes to look anything up.

- All the above references give the name(s) of the author(s), their initials, and the year of publication. References to periodicals should include the title of the periodical (underlined or italicized), the volume number, the issue number (where there is one) or the date of issue (particularly for a weekly periodical), the title of the article, and the page number of the first and last pages. Book references should include the title of the book (underlined or italicized) and the name of the publisher and the place of publication. Give the title of any reports you refer to and a sentence explaining their source if they are not published by a recognized publisher.

- You must acknowledge *all* your sources of information, whether publications or people. You will be credited for this. You will be penalized if you try to claim as your work something that was not.

- Producing a reference list *after* completing your project can be tedious and result in inaccuracies. You may have returned a paper to the library, and will have to waste time looking up references. Therefore, *we suggest you make notes on the references as you read them* or take material from them, following the style given above.

- Appendices, acknowledgments, and references are not normally given a section number, but if you include more than one appendix, give each a number of its own (e.g. Appendix 1: Electrical Specification).

The place of computer programs

Some projects involve software development. At one extreme this may be the point of the project and will then be examined by a member of HKMU's academic computing staff. (You will be aware of this at the start of the project.)

On the other extreme, it may be a fairly standard program that you have either written or adapted.

Simple programming and data manipulation are considered a means to an end, and details can often clutter up the text. If you have undertaken something which you consider above the ordinary, include a description of the procedure in the text and *confine details of any software to an appendix*. This will allow you to present your findings clearly.

If, however, you have based your work on a novel mathematical model, you should describe this in the text.

It is known that some students get hooked on computing during their projects, and they associate the time spent on it with actual study time. This is seldom justified, and if your project is not specifically on computing then beware of spending excessive time at a keyboard.

Measurement and accuracy

Where your work is based on experiments that include actual measurements, it is necessary to give the reader some indication of the anticipated errors. The analysis of experimental errors is a complex and fascinating field, but for the present purpose two concepts are important:

a) the apparatus or machine will, almost certainly, be inaccurate in itself, and

b) the act of taking an experimental reading is inaccurate.

Machine and human errors fall into two categories; systematic and random:

1 *systematic* errors are always incurred in the same sense. For example, if I were timing the interval between two events, the stopwatch I was using might go 'fast' and therefore always underestimate the actual time interval.

2 the exact instant I press the start and stop buttons is, on the other hand, an example of a *random* error. I might under or overestimate the time, depending on my reactions.

It is possible to reduce systematic errors by using more accurate equipment, and one of the criteria of good apparatus design is to minimize systematic errors.

Error analysis

Mathematical and graphical error analysis has been developed to enable the experimenter to estimate the total probable error in his/her final result.

For example:

Suppose the gauge length, *l*, of a rectangular cross-section specimen as measured by a travelling microscope was 51.24 mm. The uncertainty in position at either end of the gauge length was ± 0.02 mm. The *maximum* error is therefore simply ± 0.04mm. However, it is unlikely that both readings were out by 0.02mm in the same sense. So the probable error is defined as

$$e_{prob} = \sqrt{e_1^2 + e_2^2}$$

In our case the probable error in the length

$$e(l)_{prob} = \sqrt{0.0004 + 0.0004} \cong 0.03 \text{ mm}$$

and therefore

$l = 51.24\ (\pm 0.03)$ mm

This may also be written as

$l = 51.24$ mm $\pm$ 0.03 mm

If this measurement were to be used in a calculation of the volume, V, of the specimen within the gauge length it is this probable error that would be used :

$V = l \times b \times h$ (where b is the breadth and h is the height)

$$e(V)_p = \sqrt{e(l)_p^2 + e(b)_p^2 + e(h)_p^2}$$

which is identical to the square root of the sum of the squares of all the six measurements involved.

$$e(V)_p = \sqrt{e(l_1)^2 + e(l_2)^2 + e(b_1)^2 + e(b_2)^2 + e(h_1)^2 + e(h_2)^2}$$

More problems occur when formulae with denominators are used. In this case, the errors are still additive. I have only touched on a few aspects of error analysis. For a more detailed approach and one which covers most areas of this subject, *Errors of Observation and their Treatment* by J. Topping, is a useful text. It is conventional practice to give the errors either as ± (as shown above) or drawn as error bars (lines) through the points on a graph.

Where you are giving points that represent the means of some data points, then it is conventional to express the error in terms of the number of standard deviations, normally two, which correspond to a 95 percent error limit. The ± error-bar notations are used as before.

Examiners will expect you to be familiar with standard statistical tests to assess correlations and confidence limits when comparing data. Remember that the mindless acquisition of data, either from an experiment or from a survey, without proper regard for their significance, is *an indication that you do not understand the basic principles* underlying your project.

9. Structure Of Your Final Report

It is probably wise to follow the commonly accepted practice of dividing your writing into sections under headings similar to these:

Title page

Summary (see below)

Contents page

Introduction

Aims

Main text and Discussion

Conclusions and recommendations

Acknowledgments

References

Appendices

Summary

You must include a summary of your report.

The summary may be as brief as 200-250 words and should never be more than one side of A4. It should fulfil two purposes:

- it should provide a general picture of the report and its contents, for someone who has not yet read the report itself, but who, as a result of reading the summary, may subsequently wish to do so;
- it should also serve as a very useful aide-memoire for someone who has read the report but wishes to have an overview readily available.

The range of projects on *ELECS402/S403/S404* makes it impossible to be prescriptive about the content and style of a summary. Indeed, there is no agreed standard layout, but students should be aware of the purposes outlined above and structure the summary accordingly.

The summary should therefore

- say something about project objectives and methodology adopted;
- include any necessary background information;
- comment on any findings or results;
- emphasise any major conclusions;
- have a value as a stand-alone document, giving enough information for the reader to understand what the project has all been about.

In other words, the summary must be concise, self-contained, and self-explanatory.

Introduction and Aims

The introduction should give the content of your project, placing it in the context of other relevant work in the field. This should be followed by a formal statement of the aims of your work.

Main text

The main text consists of one or more sections covering procedure, experimental work, data collections, tabulated or summarized results, and an analysis of the accuracy and significance of the results.

In subdividing your sections into a more detailed structure, there are two major factors to consider:

1 the coherence and logic of the argument;

2 a strategy for capturing the reader's interest.

Conclusion and recommendations

The conclusion and recommendations sum up your achievements and failures and point the way to future work, which may well be taken up by students of the *Electronics Project Course* in future years.

10. Examples of Good Practice

The basic structure of any Final Report should follow that described in the previous section.

Although within the formal structure, most projects will contain substantial differences, the Course Team felt that it would be helpful to include in this section some examples of good practice. As well as dealing with specific aspects of the content of the Final Report, they also allow you to see some of the different styles of layout and lettering that might be employed.

The examples belong to different disciplines, so you should look at them from the point of view of seeing how something *could* be done, or incorporated, rather than how it *must always* be done.

Example 1

Summary

The original project objective was to investigate the methods available for concentration or density measurement within multi-phase flows. The findings were to be applied to a particular industrial situation that was concerned with oil density measurement in a production process involving glass fibres. It was intended that a suitable transducer would be designed and built based on the findings and that the transducer would be installed online to achieve the desired measurement signal.

However, as the project progressed a problem developed concerning electrostatic build-up, the discharge which prohibited the use of the transducer and associated sensors online. Thus, a change of direction was required and a study of electrostatics with relevance to the particular application was undertaken. The original design and build objective was continued with, carrying out testing off-line at the appropriate time. In addition to this, a risk assessment study was conducted concerning the electrostatic problem.

The results of the project indicate that it would be possible to use a system based on capacitive sensing techniques to gain the required measurement signal online. Major conclusions to be drawn from the project include, that it would be possible to design a system for use, based on the findings, that would be safe for use in a hazardous environment.

Example 2

Contents

Example 3

Contents

Example 4

1 Introduction

1.1 Background to the project

This choice of the project arose from the author's interest in control engineering and his belief that the discipline of engineering, in general, can benefit from studying how nature solves problems. Fuzzy control fits well in both of these categories. It is finding an increasing number of applications in control engineering and indeed is likely to become an important additional tool for control engineers. It is also the likely method of how humans and possibly other animals adapt to and learn to cope with, everyday problems – it certainly models the process of animal learning and adaptation.

1.2 Project Objective

The objective of the project is to design and implement, in simulation, a fuzzy logic control algorithm and compare the performance against a conventional reference controller. This will involve understanding the theory of fuzzy control and classifying control schemes to which fuzzy control can be most suitably applied.

1.3 Methodology

To meet the objective of the project a thorough grounding in the subject of fuzzy logic and its application to control engineering was required. The first step was to find a body of relevant literature from which to build this grounding and this was done primarily through searching a computer database.

From the results of the search, selected papers were obtained and a period of fairly intense reading was undertaken. This initially covered the fundamentals of fuzzy logic and later progressed to the specific application of the control of processes similar to that described in this paper.

An item of the plant needed to be selected, to which the fuzzy controller could be applied. Also, a reference control scheme was required, against which the performance of the fuzzy controller could be compared. Ideally, this scheme had to be flexible enough to be extended should the task of developing the controller prove a simple one, while still being a realistic scheme. Finally, both the plant and reference controller had to lend themselves to being easily modelled by computer simulation. The item of plant that fulfilled these criteria was a dc motor which could, if required, be applied to a robot arm that lifted varying loads.

Computer models of the plant and reference controller would be built and the response plotted. A fuzzy controller would then be developed and optimised and the response compared with the reference scheme. One of the claims made for the benefits of fuzzy control is its insensitivity to load changes. This aspect is investigated and compared against the response of the reference controller.

1.4 The literature search

An initial search of the IEE Inspec computer database was conducted just before work on the project started in earnest. At this stage, the only information that had been read on the subject was a small number of introductory articles in electronic trade magazines. The search keywords used were kept very general as the author believed that there would be few relevant references available. This assumption turned out to be grossly inaccurate. The keyword sequences used were:

- FUZZY
- FUZZY with LOGIC

The first sequence returned 4,062 entries, while the second returned 843 entries. These numbers were quite daunting at this early stage with no criteria available to be more selective. It was decided therefore to list twenty of the most recent papers and to select the most relevant sounding papers from them. None of these papers appeared to be particularly relevant to this project and therefore it was decided to conduct another search, once more specific keywords had been defined.

After consultation with the librarian who was to search, a new strategy was drawn up. The IEE Inspec database was used again, this time with the following constraints:

Keywords;	FUZZY with CONTROL (LER)
Other constraints;	English language,
	later than 1985.

This returned a more manageable total of 138 references and a list was produced of these. These were still so far too many to order and so five loose categories were drawn up in which to place the references.

- general industrial applications
- robots
- stability
- mobility of robots
- general fuzzy control techniques

Twenty-three papers fell into one or more of these categories and from this reduced list eight of the most relevant-looking papers were ordered. These were supplemented by approximately fifteen papers, covering in the main the more fundamental and historical background of the subject. These were supplied by Dr. R S Burns of the University of Plymouth.

As a result of reading these papers two textbooks were obtained which provided useful additional information.

Example 5

Aims and Objectives

The principal aim of this project was to establish energy or fuel consumption guidelines in domestic properties. These properties are council-owned and are refurbished estate by estate as finances will allow. These refurbishment schemes, although successfully designed and implemented, provide no actual information to the tenants concerning running costs – will they increase or decrease, will they increase but provide a warmer home? It was decided to carry out this project to obtain running costs, both per week and on a square metre basis which would allow predictions to be provided on future schemes, involving similar house types. Comparisons would also be made of actual running costs with running costs predicted by the National Home Energy Rating (NHER) Homerater program. Figures showing that the council is reducing the levels of carbon dioxide emitted into the atmosphere will also be available from the NHER program.

Example 6

The student used 10 samples per period and chose to ignore harmonics higher than the 5th because of their small amplitude.

Possible Sampling Rates					
Sampling Frequency		Sampling Interval		Harmonics measured	Samples per Period
50 Hz. System	60 Hz. System	50 Hz. System	60 Hz. System	----	----
500 Hz.	600 Hz.	2.0 mS.	1.67 mS.	5th	10
600 Hz.	720 Hz.	1.67 mS.	1.39 mS.	6th	12
700 Hz.	840 Hz.	1.42 mS.	1.19 mS.	7th	14
800 Hz.	960 Hz.	1.25 mS.	1.04 mS.	8th	16

Table 3.1 Digital Sampling Rates

Measurement of the 2nd and 5th harmonics is essential for particular transformer protection algorithms. 2nd harmonics are used to restrain tripping actions during the energisation of a transformer. 5th harmonics are used to restrain action during transformer over-excitation [Hermanto et al[34]].

Thus a design for a data acquisition subsystem should be capable of measuring up to at least the 5th harmonic to allow a standardised subsystem to be employed on all the feeders. However, it may prove essential to use a lower sampling frequency on some inputs, if a single processor is to address multiple inputs.

4.1.1 Effect of Sampling Rates on the Algorithm

A relaying algorithm has been estimated to require approximately 2000 machine instructions to execute [Phadke & Thorpe 1988[B4]]. The speed of execution of the microprocessor depends on the size of the datapath and the clock frequency at which the machine operates. High-performance PC's can now achieve speeds of approximately 14 million instructions per second (MIPs). This is equivalent to an execution time of about 75 nanoseconds.

On a 60 Hz System:

$$\frac{1.39 \times 10^{-3}\ \text{S}}{2000 \times 75 \times 10^{-9}\ \text{S}} = 9.3$$

On a 50 Hz System:

$$\frac{1.67 \times 10^{-3}\ \text{S}}{2000 \times 75 \times 10^{-9}\ \text{S}} = 11.1$$

If this performance could be achieved in the protection processor while operating with a sampling rate of 12 samples per period then on a 60 Hz system a maximum of 9 inputs could be sampled and 11 inputs on a 50 Hz system.

However, this does not take into account the requirements for machine self-testing programme or communications loading. Thus it should be seen as a limiting performance rather than a practicable target.

4.2 Sampling Rectified Inputs

If it is not essential to extract frequency or phase information from the input, then it may be full.

Example 7

CHAPTER FOUR

Risk Assessment

4.1 Introduction

Chapter Three has demonstrated that a potentially serious hazard exists in the considered application due to electrostatics. From the finding of the chapter, it is possible to make some judgments based on previous experience and knowledge gained in similar work that will allow a partial form of risk assessment. However, to ensure that the intended system will be safe for use in the particular application being considered, it is necessary to use some measurement techniques that will allow quantitative assessment. These measurements are designed to assist in evaluating whether or not the proposed system would be safe for use.

BS958 describes several tests currently available for quantifying electrostatic-related parameters. These tests include measurement of electrical conductivity, volume resistivity, charge density, and minimum ignition energy. The latter of these parameters is looked at more closely in the following section of this chapter.

Other sources which describe details of tests in industrial situations, include SIRA Communications tutorial notes which describe three techniques for use in determining electrostatic parameters. These techniques are Faraday container/electrostatic voltmeter, current electrometer, and measurement of electric field strength. To serve as a supplement to any practical tests carried out it may be possible to interpret data concerning flammable materials which is contained in suitable tabular form. One example of such data is contained in BS5345, Parts 1 and 4, where detailed information such as flammable limits and minimum igniting current is available for a comprehensive range of flammable materials.

4.2 Minimum Ignition Energy Considerations

It was stated in Chapter Three that in any risk assessment study the ability of the material(s) under consideration to inflame or explode is of paramount importance. Therefore, the parameter of minimum ignition energy needs to be carefully considered. This parameter is a measure of how much energy is required (usually measured in millijoules) to ignite a substance under scrutiny.

Unfortunately, it is not always a straightforward task to measure the required ignition energy due to several factors. These include dependence on particle size in dust clouds, the volume of air that particles are combined with, and finally chemical construction of the particles. However, standard particle size for use in tests has been developed through experience, and consequently, the sensitivity of a dust cloud to ignition is usually determined by using dust that is capable of passing through a 200 mesh (75 micrometers) sieve (BS5958).

Considering the proposed system under assessment from the point of view of possible ignition sources, the flow is made up of two elements, which are treated glass fibres and oil.

Example 8

6 Conclusion and Recommendations

6.1 Conclusions

The final fuzzy control model has proved to be a success, outperforming the velocity feedback model, which is itself a very powerful technique. The performance of the fuzzy controller was superior to the reference controller both at controlling the dc motor under normal operating conditions and when subjected to an increase in inertia. Having said this, caution must be exercised as the controller is only a model, and before true success can be claimed the design should be implemented in hardware. However, at this stage, a good degree of confidence is warranted.

The work has highlighted the need for a formal design and optimisation procedure that should aid the more widespread understanding and application of fuzzy control. Although no one design methodology applies to the implementation of fuzzy control a procedure has been described by which a fuzzy control scheme can be developed, tested, and optimised. Graphical methods have been employed in this task and the author believes that the design process could be improved by extending these methods.

The techniques employed in the design process, the use of BASIC programs, and analysis using a spreadsheet, while adequate for a project such as this are not suitable for the commercial application and design of fuzzy control systems. Keeping track of the various amendments to the design as this progressed was a difficult, time-consuming process that was also prone to errors.

Time did not permit the classification of the types of control schemes that would particularly benefit from fuzzy control. Indeed considerable experience in fuzzy control would be required before such a task could be applied to any degree of accuracy or with any confidence. The equipment to which the fuzzy controller was applied was not extended from the dc motor to a robot arm, again because of the lack of time.

6.2 Recommendations

The recommendations for further work fall into two groups:

- those relating to the development of this specific model
- those relating to the subject of fuzzy control.

Relating to the model

As stated earlier, the final model requires checking by implementing in hardware, as only by doing this can complete confidence in the design be achieved.

An investigation would be useful as to why the version of the course and fine model, that used more sensitive parameters, failed when other researchers have reported improved performance.

Relating to fuzzy control in general

There are many areas of fuzzy control that will benefit from further investigation, but those listed below lead directly from the work undertaken in this project or relate to questions that apply to the implementation of the model in hardware.

An integrated fuzzy control system design and development program should be developed that would ease the task of development and indeed the understanding of fuzzy control systems. An interactive computer-based graphical environment would seem to be the most applicable to this task.

A design procedure should be developed that would allow a formal quality control audit to be achieved. Also, the development of a methodology for optimising the performance of controllers is needed.

An aspect that has not been addressed by this project, but one that would need to be before the model could be constructed in hardware, is, to what extent does the choice of sample rate have on the performance of fuzzy controllers and can existing relationships (e.g. Nyquist sampling theorem) be used? No guidance has been found on this subject in all of the literature read in the course of completing this project.

Example 9

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