

MEI STRUCTURED MATHEMATICS

Marking Differential Equations Coursework

**10 tips to ensure that the right mark is
awarded**

Differential Equations Coursework

Rationale

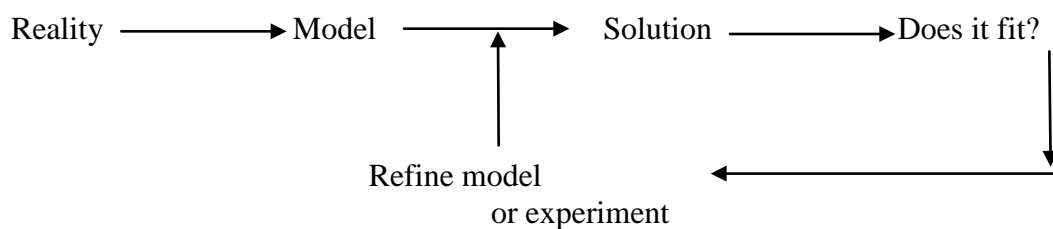
The aims of the coursework are that students should learn how differential equations are used to solve real-world problems and that they should appreciate how the theory they have learnt for the examination helps them to do this.

The objectives are that they should undertake the various steps in the problem solving procedure. The assessment criteria are closely related to these steps.

The modelling cycle

The intention is that the modelling cycle will be followed. It has the following essential elements.

- (i) Assumptions need to be made to the model to enable a solution to be found.
- (ii) The model is worked and predictions are derived.
- (iii) The experiment is carried out to provide data.
- (iv) The experimental data are compared to the predictions from the model.
- (v) Amendments are suggested to the assumptions that might improve the match between experiment and model. The model may be reworked.
- (vi) Amendments may also be made to the experiment, particularly in the method of collecting the data in order to improve the match.



The work

This is a piece on Differential Equations from the module. The equation(s) must be set up from mathematical or mechanical principles. *It is not just a curve fitting exercise.*

These equations need to be solved to give a set of predictions. The real data may be collected from an experiment or data presented to the students.

The format of assignments

1. Student's Brief

This is intended to be given to students before any work is attempted. Work in the classroom should begin with the first ideas that students themselves can contribute. Discussion amongst themselves (within a teaching group) with teacher guidance, will usually bring out the significant features of the problem and a line of enquiry will be opened up.

2. Teachers' Notes

These are designed to indicate to the teacher some possible features of this discussion. They may indicate certain pitfalls to be avoided, or starting points for work on the problem. These notes should not be shown to students; their content should be fed into the classroom by the teacher at appropriate moments.

These notes should not be shown to students.

3. Marking Notes

These indicate which marking scheme is appropriate in cases where there is a choice and how the criteria might be applied under the various headings of the marking scheme. These notes should not be shown to students.

These notes should not be shown to students.

Marking Schemes

There are two marking schemes.

Scheme A

The emphasis is on the modelling which will require a fair amount of algebraic and mathematical manipulation to produce a solution. The experiment is done (or data collected by some other means) to verify the predictions, or otherwise.

Scheme B

There is an equal emphasis on the modelling and the experimental sides of the process.

A Code of Practice

It is recommended that all teachers follow this code for the implementation and assessment of coursework assignments.

Phase 1: Teacher preparation

This phase should be considered well in advance of the start of any work by the students.

Attempt one or more assignments from this bank yourself. In the case of a model, this allows you the opportunity to obtain a feel for the problem; in the case of an experiment, to assess the need for and availability of equipment. In neither case does this exclude the possibility of alternative approaches suggested subsequently by students, but it will allow you more easily to head them away from blind alleys. Read the Teacher's Notes also at this stage.

Phase 2: Student preparation

This should take place a week or two before work starts to enable students to consider the problem to be tackled.

Issue copies of the brief(s) to the students for the chosen problem(s), and copies of the marking scheme(s) to be used, as printed in the syllabus. (If subsequent work takes an unexpected direction such that one of the other marking schemes is more appropriate, this change should be explained to the students.)

Phase 3: Doing the Task

Discuss with students their suggested approach to the problem. Do not be afraid of a “void” at this point as facing this is a vital part of the student's learning process. Give time for students' understandable reticence to be overcome; by experience you will be able to draw out students' own ideas. You have the (confidential) Teacher's Notes to consult, but at this stage the students should be thinking for themselves.

Work begins, and continues with teacher guidance and discussion. Respond to requests for assistance, and intervene to avoid blind alleys, but try to leave the initiative with the students. It is not only acceptable but also in many cases beneficial for students to work in small groups, sharing the workload and pooling the results.

Make sure that the students understand the mark scheme. In doing this, it can be helpful for you to keep a list of important points that arise as work progresses. These can be allocated to the various domains and used later as a guide to allocating marks. This can considerably reduce the marking time.

You are particularly likely to have to explain the section headed “Variability”. The ideas involved may well be new to students; they are rarely covered satisfactorily in a purely theoretical course.

Phase 4: Final write-up

When students start to write their report, the teacher's role changes from being an aid to the students' progress to being a representative of the Examining Board. Consequently, it would be unethical to assist with the write-up or to allow further amendment once the assessment has begun.

The write-up of the work done should be completed individually by each student and it is **crucial** that you ensure that this is done, especially when students have worked on the task together and have produced the same data. The finished report should enable a fair assessment of what the student has achieved, either individually or as part of a group.

Collect work, suitably labelled; it is especially helpful to the assessment and external moderation process if the pages are numbered. The finished report should be held together in its entirety, at least by a treasury tag, a staple, or a folder. A copy of the appropriate mark scheme should be included at the front – students may fill in the details at the top of these, including their examination candidate number. This sheet has been used as a guide by the student, and will be required for assessment and external moderation.

Phase 5: Assessment of written work

Read a representative sample of the work submitted. This process, together with any notes you have made during the course of work under the various marking scheme domains, should enable you to clarify your expectations for the marks in each domain.

Now you are ready to assess each piece of work. As you do so, use the assessment sheet to note significant features relevant to the various domains (by page number if possible) in the comments boxes provided. These comments and annotations on the script are extremely helpful to an external moderator; the more you show how you have come to make an assessment, the more likely is a moderator's agreement. If there is a disagreement, it is much easier to indicate the reason in a constructive way.

The marking schemes are designed to establish the extent to which a student's work shows mastery of the essential processes involved in the relationship between models and experience. They are not intended to distinguish between levels of excellence at the top end of the ability range. Beware of depressing marks of students who have essentially mastered the objectives of the task but who have not reached the standards of excellence established by one or more outstanding pieces of work. Note also that an experiment which eventually does not "work" does not thereby invalidate its write up for assessment, since evaluation of the reasons for failure is a valid part of the process.

Assessors need to note the following points:

- In a case where you are aware that the student has received a great deal of teacher input, consider the extent to which the student now shows mastery of the area concerned.
- Cases of apparent similarity of two or more students' reports (that is, beyond stated pooling of results) should be challenged during the oral communication assessment.
- If the award of half marks in various domains results in a total which is not an integer then the mark must be rounded up or down, depending on your feeling about the value of the work.

Phase 6: Oral Communication assessment

There are various ways in which Oral Communication can be assessed, depending on the circumstances of the teaching group as much as on the problem itself.

(a) Presentation

A student (or students if they have worked together on the same task and have collected the same data) should be invited to give a presentation to the teaching group together with the assessor. While each student should contribute enough of the presentation to fulfil its purpose the whole presentation should take no more than 10 minutes and include brief details of the preparation and execution of the task together with results and conclusions. The use of visual aids should be encouraged. An economic use of time for a large teaching group is that they should be split into a number of smaller groups (of, say, six students) so that the audience is not too large and so that each student should not have to listen to too many presentations! The Assessor may wish to ask pertinent questions at the end to check on the authenticity of the work.

(b) Interview

The Assessor conducts a short, one to one, interview with each student with the work available to enable each student to have the opportunity to talk about their work and for the assessor to establish authenticity. Such an interview need take no more than 5 minutes.

(c) On-going discussion

If some of the report is written up during class time then the assessor can engage each student in a discussion of the report being written. This will have the same effect as the interview, but is carried out in a much less formal way.

A comment on the mark sheet should explain how the assessment was made and any points that will indicate why the mark given was awarded. Any special circumstances that led to the mark being awarded should also be noted.

Phase 7: Moderation

It is essential that as a result of the assessment the work of all the candidates in each group is correctly ranked and the Assessor must be satisfied that this is the case before the process of internal moderation begins.

It is the role of the co-ordinator of internal moderation to see that standards are equalised between teaching groups in a Centre. Generally it will suffice to verify three scripts representing the range of marks from each marker, unless this produces evidence of disagreement.

The external moderator has two tasks:

- To check from a representative sample of a Centre's work whether a valid order of merit has been achieved,
- To check that the Centre is marking to the same standard as other Centres.

1 Get the scheme right

Sometimes we are faced with the moderation of a task that has been assessed using the wrong scheme. For instance, in Scheme B there are 5 marks available for the description and the results of doing the experiment. These 4 marks are not available to a candidate who presents a task such as “Aeroplane Landing” where there is no experiment.

The following assumes scheme A but the same points could be made for scheme B.

2 Simplifying assumptions – relative importance

The criteria demand something to do with an awareness of the relative importance of the assumptions being made. Simply writing down a list of assumptions with no explanation does not fulfil this criterion.

3 Simplifying assumptions - relevance

Likewise, the relevance of the assumptions needs to be discussed to gain the second mark in this domain.

4 Differential equation

If the model is in two parts, such as “Aeroplane Landing” then the differential equation(s) must cover both parts. It is not satisfactory to accept or reject a model based on comparison with only part of the motion.

5 General solution

The solution must cover the whole motion.

The assumptions must be such that the model to be solved lies within the specification. For instance, it would not be appropriate to make an assumption, in “Aeroplane Landing” that there was no air resistance. If there were no air resistance then the differential equation for the model would be too easy at this level.

6 Particular solution

This requires sensible choice of boundary conditions or initial conditions.

A set of predictions should be obtained, not just a graph of the particular solution

“Quantitative consideration” means that there could be a different choice of initial/boundary conditions. What effect would changing the choice have?

7 Data collection

A trivial mark in cases such as “Aeroplane Landing” which should mean that it is an easy mark to get. However, it is a necessary part of the report and there is a mark available. Given that the model should be aiming to match the data and not vice-versa, that the data should be listed first together with any limitations.

8 Comparison

Graphs and tables should be presented. Variation in the parameters also need to be mentioned.

9 Revision

One or more of the simplifying assumptions should be relaxed, and justified, This is a crucial part of the modelling process. To make a suggested amendment “to see if there is a better fit” is simply curve fitting and not modelling.

10 Conclusions

The conclusions must be stated and based on what has been found. There may have been no improvement to the results in that the comparisons with the real data may not be so good.