SM381 Module Guide

Contents

1 Introduction

This guide explains the aims of SM381 *Electromagnetism*, how to study the module, how you will be assessed, how to get help, and arrangements around accessibility.

The primary aim of this module is to teach you about classical electromagnetism. The theory of electromagnetism is the consistent system of concepts and physical laws that unify electricity and magnetism, and that describe their associated phenomena such as electromagnetic radiation.

Why is studying electromagnetism a core part of undergraduate physics?

Electromagnetism is an interesting topic in its own right as it is one of the 'fundamental forces', and electricity and magnetism are commonly encountered in nature. Moreover, electromagnetism is a key component of much of modern technology. Electromagnetism is also an example of a field theory so serves as an introduction to other field theories in physics. However, just as important as these subject-specific reasons are the general concepts and methods that you will learn while studying electromagnetism. These include:

- describing and communicating complex ideas accurately and intelligibly, using appropriate concepts and mathematical tools
- solving complicated problems by breaking them down into smaller, more manageable pieces
- using symmetries and constraints to simplify the representation of a system
- checking that your solution to a problem is consistent with other approaches or representations of the same situation.

These abilities provide a foundation from which you can study more advanced subjects in physics (including other field theories). They are also transferable skills that are important for tasks in many types of analytical work and employment. You can log the skills you learn and track your progress towards your study goals using The Open University's (OU's) FutureYOU tool. For more information on the opportunities and skills provided by studying physics, visit the Science skills and careers website. For further guidance, you can contact Careers and Employability Services including booking an individual Careers consultation.

Assumed knowledge

The module materials assume an initial level of mathematics and physics knowledge. This knowledge is provided by S217 *Physics: from classical to quantum*, and by MST210 *Mathematical methods, models and modelling* or MST224 *Mathematical methods*. If you have achieved Grade 2 or above in these modules, then you are suitably prepared. If you have not achieved this grade or wish to refresh your knowledge, there is an accompanying Preparation for Level 3 physics modules website with material designed to help you obtain the necessary familiarity. **You should take advantage of this material without delay to ensure that you keep up with the module schedule.**

SM381 is part of the Physics, and Mathematics and Physics, qualifications at the OU. It is a Level 3 module in terms of its complexity and should ordinarily be studied at Stage 3 of a

qualification pathway. For more information about qualifications, visit the Physics, astronomy and planetary science and Mathematics and statistics websites.

Tips for studying Level 3 physics modules

To understand some of the challenges of working on a Level 3 physics module and for tips on how to succeed, you can watch and listen to interviews with former OU students on the Tips for studying Level 3 physics modules website.

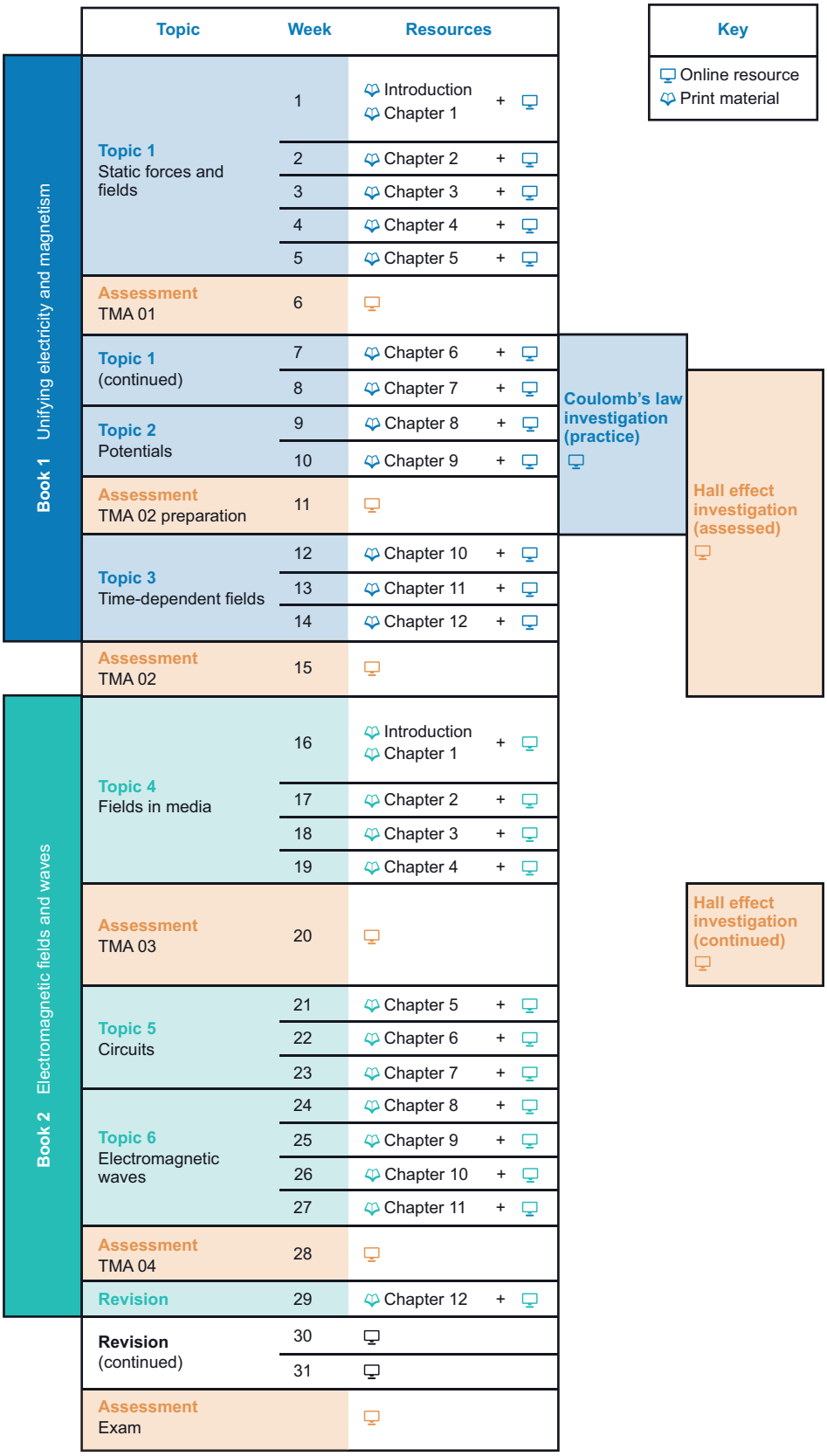
These interviews highlight the importance of:

- preparing for study, managing your time effectively and making steady progress to keep up with the module
- spending significant time and effort on practice problems and consolidation exercises
- getting support from tutors and other students, and not being afraid to ask for help
- using revision resources.

2 Studying SM381

Your learning will be guided by the module website. Each week, it will direct you to certain tasks, including reading book chapters, watching videos, undertaking a tutor-marked assignment (TMA), or carrying out an experimental investigation. You will also be provided with opportunities for self-assessment, practice and consolidation, and further reading. The weeks are grouped into six topics covering key areas of electromagnetism, followed by a revision period.

The SM381 module map provides a concise overview of the module structure to help you plan ahead (see the click-to-expand image below).



SM381 module map

For 24 weeks of the module, you will work through a book chapter each week before returning to the module website to view resources for further self-directed study. Some

weeks will also involve online investigations concerning Coulomb's law and the Hall effect.

2.1 Resources

The components of the module that are related to your learning are described in this section (except the TMAs and end-of-module exam, which are described in Section 3).

The module website

The home page of the module website features a study planner that indicates the tasks you should undertake each week. Use this to keep track of your progress. It will also indicate when you need to start and complete assessments, including the tasks associated with the investigation that forms TMA 02.

Most weeks have an overview page, and the first week of each topic will also give a summary of the concepts taught by that topic. The week overviews outline the subjects you will study that week, the tasks you should complete, and any associated resources. Your study is separated into module-directed and student-directed tasks. You should aim to spend approximately 5.5 hours on module-directed learning and 4.5 hours on student-directed learning each week.

The overview will indicate your module-directed tasks for the week, which can include reading book chapters or completing an online experiment. The overview will also describe possible student-directed tasks. Spending time on student-directed learning is as important as module-directed learning, but you are invited to tailor the specific tasks to your study needs. For example, quizzes are provided so that you can self-assess your knowledge and understanding. You could also watch a problem-solving video to help you understand a tricky concept, or you could read some material that allows you to practise the skill of applying your knowledge of electromagnetism to an unfamiliar situation. You may even wish to re-read a previously studied chapter from the SM381 books if you found it particularly challenging.

The module website also hosts forums where you can discuss the module with other students, tutors and the OU academics that run the module. This is a good place to ask specific questions about module topics, and also offers an opportunity for you to try to help other students by answering their questions.

The books

Two books are provided that contain the core reading material:

- Book 1 *Unifying electricity and magnetism*
- Book 2 *Electromagnetic fields and waves*.

Book 1 describes Maxwell's equations and how to use them, and explains how they constitute a unified theory of electromagnetism. Book 2 describes electric and magnetic phenomena in matter, and electromagnetic waves.

Individual book chapters are designed to be read within a single week. When you read through a book chapter, you should also work through the examples and exercises it contains. The books cover the knowledge required by the module, but working through them alone will not develop the necessary ability to apply this knowledge. Therefore, it is vital that you also engage with further practice and consolidation activities as provided by the module website if you are to succeed in your assessments.

Tutors and tutorials

You will be allocated a module tutor who will mark your TMAs and will be able to provide help with SM381. You should not hesitate to contact your tutor about any academic question that you have relating to SM381.

There are multiple tutorials spread throughout the module. Tutor-group tutorials will consist of a smaller number of students assigned to the same tutor. They will focus on things like tailored feedback on TMAs. There will also be larger module-wide tutorials that include problem-solving workshops.

You should do your best to attend all of your tutorials. Problem-solving workshops are not recorded, but are repeated on different days and at different times, and summaries of the problems discussed will be provided.

Practice and consolidation

Short self-assessment quizzes are provided throughout the module. They can be taken as many times as you like, allowing you to develop your understanding and practise your problem-solving abilities on short problems. There are also longer additional exercises with solutions to help you consolidate your understanding of concepts introduced in the books. Other practice and consolidation resources include online interactive tools, problem-solving videos and further readings.

In most cases, timings are included with these resources to help you plan your study. These timings are only approximate, and you may choose to only do part of an activity, or spend less or more time depending on your needs and interests. However, if you find you are stuck, or an activity is taking much longer than expected, then you might want to seek help.

Getting help

If you need help with studying the module, you can contact your tutor or you can ask a question on the module forums. For more general help, queries and advice, you can contact your student support team via the Contact the OU website.

2.2 Investigations

There are two online investigations in SM381:

- **Coulomb's law investigation** This investigation takes the form of an interactive screen experiment, an online tool that allows you to carry out an experiment in a virtual laboratory. This is a non-assessed 'practice experiment' involving Coulomb's law, which you will learn about in Week 1. This investigation is designed to help you practise your experimental skills in preparation for the assessed Hall effect investigation and TMA 02. You are recommended to carry out this practice investigation by the end of Week 11.
- **Hall effect investigation** This is the main practical investigation in SM381 and is assessed in TMA 02. In this investigation of the Hall effect, you will remotely control equipment located at the OU campus in Milton Keynes (UK), using a digital interface that is accessed via your web browser. You will plan and carry out the experiment with a partner, before individually analysing the collected data and preparing an experimental report in TMA 02. You also need to prepare a poster or slides to describe your investigation to a non-expert audience (note you will not be required to give a presentation).

Note

Parts of the SM381 investigations make use of The OpenScience Laboratory, and some of the tasks provide the option to use Python. See Section 4.7 and Section 4.8 of the SM381 Accessibility Guide for more details about these tools.

Tables 1 and 2 explain the tasks and timings involved in the Coulomb's law and Hall effect investigations.

Table 1 Coulomb's law investigation.

Task	Details	When (recommended)
Task 1: Practice experiment	Collect data using an interactive screen experiment (via The OpenScience laboratory).	Weeks 7–11
Task 2: Evaluation	Analyse your data, form conclusions and suggest improvements to the investigation.	Weeks 7–11

Table 2 Hall effect investigation.

Task	Details	When
Task 1: Booking the remote experiment	When it becomes available, you can access the online booking system. You may book one slot in either Set 1 or Set 2.	Booking system open from Week 8
Task 2: Background reading and planning	Read the provided background material on the Hall effect to understand the aims of your investigation. Familiarise yourself with the experiment instructions and plan your online experiment session.	Weeks 10–13
Task 3: Carrying out the remote experiment	Access the OpenScience Laboratory remote interface via your booked slot from Task 1 and use your plan from Task 2 to carry out your experiment and collect the necessary data.	Weeks 11–14
Task 4: Analysing your data	Analyse your data from the remote experiment (Task 3) to form conclusions.	Weeks 12–15
Task 5: Communicating your findings and submitting your report	Write a technical report of your investigation. You will also prepare a presentation (in the form of a poster or slides) aimed at a non-expert audience, which will be peer-reviewed as part of TMA 03.	Week 15 (TMA 02)
Task 6: Peer review	Review a presentation prepared by one of your fellow students (in Task 5) and provide constructive feedback.	Week 20 (TMA 03)

Important information about the Hall effect investigation

You will need to book, plan and perform the experiment in pairs. Your tutor will be able to assist in pairing you with another student within your tutor group.

An online event will be held before Week 11 to explain how to use the remote experiment and perform the analysis.

The poster or slides you produce to communicate your findings will be marked by your tutor as part of your TMA 02 submission. Your poster or slides will also be given to other students within your tutor group for peer review as part of TMA 03. Similarly, you will be asked to *constructively* review another student's poster or slides in TMA 03.

Collaborative work on this module should be conducted within the University's systems. You should use the discussion forums and tools that are suggested in the module materials. Avoid using third-party tools or products, such as social media platforms, for collaborative tasks.

The OU Social Media Policy covers behaviour on all forms of social media.

3 Assessment

In SM381 there are several assessments that contribute to your module result; Table 3 explains how they are weighted.

Table 3 Assessment weightings for SM381.

Assessment	Weighting (%)
TMA 01	2
TMA 02	24
TMA 03	2
TMA 04	2
Exam	70

TMAs 01, 03 and 04

TMAs 01, 03 and 04 are a crucial way to get expert feedback on your learning and ability to answer exam-style questions. Each of these TMAs consists of exam-style questions and an evaluation or peer-review question. The exam-style questions will be marked by your tutor and detailed feedback will be given to help you prepare for the final examination. Marks for these questions **do not contribute** to your final module result. The 2% is awarded for your responses to the evaluation (or peer-review) questions only.

You may submit your TMA answers as scanned or photographed handwritten work. Alternatively, you can submit mathematically typeset work in PDF or Word format. Note that if you are submitting typeset answers, it is important to not be tempted to skip steps in your working – these intermediate steps receive marks in the exam, and your tutor will provide feedback based on them.

TMA 02 (Hall effect investigation)

TMA 02 involves collecting and analysing experimental data, writing a report and producing a poster or a few slides on your findings. More details can be found on the Hall effect investigation page and within TMA 02.

Note

TMA 02 is an important assessment worth 24% of the available marks for the module. You must plan ahead for TMA 02 so that you can book a slot and carry out the remote (online) experiment **before the end of Week 14**. This will give you Week 15 (the TMA 02 week) to produce your report and presentation (poster or slides).

If you cannot perform the online experiment for accessibility reasons, an alternative activity will be provided that covers the same physics and learning outcomes (see the SM381 Accessibility Guide).

Examination

The majority of your learning in SM381 is assessed by a final remote exam of 3 hours (plus a contingency period for assembling your answers and uploading your finished work).

General information on remote exams is available in the Exam arrangements handbook.

Submitting assessments

For information about special circumstances relating to TMA submission, please see the Assessment Handbook.

Information on how to scan, photograph or otherwise capture your answers and submit them is given on the Student guidance for preparing and submitting TMAs page of the Mathematics and statistics website.

Plagiarism

Each assessment includes a plagiarism warning. Make sure you read and understand this warning.

Note that for TMA 02 (the Hall effect investigation) you will be expected to plan and perform the experiment in a pair and although you may discuss your results and conclusions with your partner, you must prepare your written reports individually.

4 Module learning outcomes

The module learning outcomes for SM381 are given in Table 4 alongside the assessment method(s).

Table 4 SM381 learning outcomes.

Outcome	Description	Assessment method(s)
Knowledge and understanding		
KU1	Demonstrate understanding of the key ideas, concepts, fundamental principles and methods of electromagnetism and its contemporary applications.	Examination and TMA 02
Cognitive skills		
CS1	The ability to discuss the underlying concepts and interpretations of the principles of electromagnetism and in particular Maxwell's equations at a graduate level.	Examination
CS2	The ability to describe electromagnetic phenomena using vector calculus.	Examination
CS3	The ability to apply the theory of electromagnetism to an authentic experiment and obtain, interpret and analyse the results.	TMA 02
CS4	The ability to use and apply the concepts, formalism and methods of electromagnetism in conjunction with symmetry arguments to solve a range of problems, including unfamiliar ones.	Examination
Key skills		
KS1	Use digital tools and resources to retrieve, use, create, analyse and share data, information and knowledge as appropriate in electromagnetism.	TMA 02
KS2	Prepare, process, interpret and present data to communicate scientific information, arguments and ideas in the area of electromagnetism accurately and effectively using written, visual and numerical forms in a style that suits purpose and audience.	TMA 02
Practical and professional skills		
PPS1	Obtain, record, collate and analyse data derived from investigations and interpret and report their significance in light of underlying theory, practical issues and relevant information from other sources.	TMA 02
PPS2	Initiate, design, conduct and report on investigations that may involve the acquisition of primary or secondary data.	TMA 02

PPS3	Manage your learning time and work independently.	Examination
PPS4	Engage effectively with feedback.	TMA 01, TMA 03 and TMA 04

5 Accessibility

To aid accessibility, the majority of module materials are available in a variety of formats.

SM381 includes several interactive tools to help you learn concepts described in the module books. Using these tools is not required but they do have accessibility features. If you cannot use them online or in interactive form, alternative offline learning aids will be provided. Similarly, if you cannot access the two online practical investigations, there are alternative offline activities that cover the same physics and learning objectives.

Please see the SM381 Accessibility Guide for detailed descriptions of the specific accessibility provisions in this module.

The OU Library also provides accessibility support, which can be sought by contacting the Library Helpdesk.

6 Contributors

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