# MATH335
## Mathematical Methods
### S1 Day 2019

*Dept of Mathematics and Statistics*

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### Disclaimer

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General Information

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Frank Schoenig
frank.schoenig@mq.edu.au

Credit points
3

Prerequisites
MATH235 and (MATH232 or MATH236)

Corequisites

Co-badged status

Unit description
This unit develops the ideas and techniques of analysis important in many branches of pure and applied mathematics. Topics include the theory of ordinary differential equations, including linear and nonlinear systems and their stability. Some special functions are also discussed, together with important applications in various branches of mathematics.

Important Academic Dates
Information about important academic dates including deadlines for withdrawing from units are available at https://students.mq.edu.au/important-dates

Learning Outcomes

1. Knowledge of the principles and concepts of a basic theory of Ordinary Differential Equations and the theory of Special Functions.
2. Ability to use the ideas and techniques of the theory of Ordinary Differential Equations and the theory of the Special Functions to model a broad range of phenomena in
science and in engineering.

3. Ability to construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning.

4. Expressing yourself clearly and logically in writing.

**General Assessment Information**

**HURDLES:** This unit has no hurdle requirements.

**LATE SUBMISSION OF WORK:** All assignments and assessment tasks must be submitted by the official due date and time. No marks will be given for late work unless an extension has been granted following a successful application for Special Consideration. Please contact the unit convenor for advice as soon as you become aware that you may have difficulty meeting any of the assignment deadlines.

**FINAL EXAM POLICY:** You are advised that it is Macquarie University policy not to set early examinations for individuals or groups of students. All students are expected to ensure that they are available until the end of the teaching semester, that is, the final day of the official examination period. The only excuse for not sitting an examination at the designated time is because of documented illness or unavoidable disruption. In these special circumstances, you may apply for special consideration via ask.mq.edu.au.

If you receive special consideration for the final exam, a supplementary exam will be scheduled in the interval between the regular exam period and the start of the next session. By making a special consideration application for the final exam you are declaring yourself available for a resit during the supplementary examination period and will not be eligible for a second special consideration approval based on pre-existing commitments. Please ensure you are familiar with the policy prior to submitting an application. You can check the supplementary exam information page on FSE101 in iLearn (bit.ly/FSESupp) for dates, and approved applicants will receive an individual notification one week prior to the exam with the exact date and time of their supplementary examination.

**Assessment Tasks**

<table>
<thead>
<tr>
<th>Name</th>
<th>Weighting</th>
<th>Hurdle</th>
<th>Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 assignments</td>
<td>30%</td>
<td>No</td>
<td>See the iLearn for details</td>
</tr>
<tr>
<td>One Test</td>
<td>20%</td>
<td>No</td>
<td>Week 9</td>
</tr>
<tr>
<td>Exam</td>
<td>50%</td>
<td>No</td>
<td>University Examination Period</td>
</tr>
</tbody>
</table>

2 assignments

*Due: See the iLearn for details*

*Weighting: 30%*

Assignments on Ordinary differential equations and Special functions
This Assessment Task relates to the following Learning Outcomes:

• Knowledge of the principles and concepts of a basic theory of Ordinary Differential Equations and the theory of Special Functions.

• Ability to use the ideas and techniques of the theory of Ordinary Differential Equations and the theory of the Special Functions to model a broad range of phenomena in science and in engineering.

• Ability to construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning.

• Expressing yourself clearly and logically in writing.

One Test
Due: Week 9
Weighting: 20%
Supervised in class test.

This Assessment Task relates to the following Learning Outcomes:

• Knowledge of the principles and concepts of a basic theory of Ordinary Differential Equations and the theory of Special Functions.

• Ability to use the ideas and techniques of the theory of Ordinary Differential Equations and the theory of the Special Functions to model a broad range of phenomena in science and in engineering.

• Ability to construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning.

• Expressing yourself clearly and logically in writing.

Exam
Due: University Examination Period
Weighting: 50%
Final exam

This Assessment Task relates to the following Learning Outcomes:

• Knowledge of the principles and concepts of a basic theory of Ordinary Differential Equations and the theory of Special Functions.

• Ability to use the ideas and techniques of the theory of Ordinary Differential Equations and the theory of the Special Functions to model a broad range of phenomena in science and in engineering.
• Ability to construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning.
• Expressing yourself clearly and logically in writing.

Delivery and Resources

Classes

Lectures: you should attend two hours of each lecture stream each week, making a total of four hours per week.

Required and Recommended Texts and/or Materials

ORDINARY DIFFERENTIAL EQUATIONS

• *Ordinary Differential Equations and Stability Theory* David A. Sanchez, Dover
• *Ordinary Differential Equations and Stability Theory* V.I. Arnold

SPECIAL FUNCTIONS

No single textbook is entirely satisfactory for this part of the course. Attendance of the lectures is strongly recommended.

• *Advanced Engineering Mathematics* Erwin Kreyszig, John Wiley&Sons, various editions. QA401.K7
• *Equations of Mathematical Physics* A.N. Tikhonov & A.A. Samarskii, Oxford University Press (also reprinted by Dover). QA401.T512/1963

Technology Used and Required

Students are expected to have access to an internet enabled computer with a web browser and Adobe Reader software. Several areas of the university provide wireless access for portable computers. There are computers for student use in the Library and MUSE.

Difficulties with your home computer or internet connection do not constitute a reasonable excuse for lateness of, or failure to submit, assessment tasks.

Unit Schedule

<table>
<thead>
<tr>
<th>WEEK</th>
<th>ODES</th>
<th>SPECIAL FUNCTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction. First order equations.</td>
<td>Power series solutions to 2-nd order ODF with variable coefficients.</td>
</tr>
<tr>
<td>2</td>
<td>Existence &amp; uniqueness, successive approximations.</td>
<td></td>
</tr>
<tr>
<td>Unit</td>
<td>Topics</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>--------</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Second order linear equations, fundamental sets, reduction of order.</td>
<td>Legendre equation. Legendre functions.</td>
</tr>
<tr>
<td>4</td>
<td>Higher order linear equations.</td>
<td>Properties of Legendre functions.</td>
</tr>
<tr>
<td>5</td>
<td>Higher order linear equations.</td>
<td>Frobenius method to solve ODE with variable coefficients. Bessel equation.</td>
</tr>
<tr>
<td>7</td>
<td>First-order linear systems: fundamental set of solutions. Systems with constant coefficients</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>Sturm-Liouville problems.</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>Series expansions in special functions. Application to solving partial differential equations.</td>
</tr>
<tr>
<td>12</td>
<td>Limit cycles and stability.</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Revision</td>
<td>Revision</td>
</tr>
</tbody>
</table>

**Policies and Procedures**

Macquarie University policies and procedures are accessible from [Policy Central](https://staff.mq.edu.au/work стратегии планирования и управления/политики и процедуры/_policy-central). Students should be aware of the following policies in particular with regard to Learning and Teaching:

- Academic Appeals Policy
- Academic Integrity Policy
- Academic Progression Policy
- Assessment Policy
- Fitness to Practice Procedure
- Grade Appeal Policy
- Complaint Management Procedure for Students and Members of the Public
• **Special Consideration Policy** *(Note: The Special Consideration Policy is effective from 4 December 2017 and replaces the Disruption to Studies Policy.)*

Undergraduate students seeking more policy resources can visit the Student Policy Gateway (https://students.mq.edu.au/support/study/student-policy-gateway). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

If you would like to see all the policies relevant to Learning and Teaching visit Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central).

**Student Code of Conduct**

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/study/getting-started/student-conduct

**Results**

Results published on platform other than eStudent, (eg. iLearn, Coursera etc.) or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in eStudent. For more information visit ask.mq.edu.au or if you are a Global MBA student contact globalmba.support@mq.edu.au

**Student Support**

Macquarie University provides a range of support services for students. For details, visit http://students.mq.edu.au/support/

**Learning Skills**

Learning Skills (mq.edu.au/learningskills) provides academic writing resources and study strategies to improve your marks and take control of your study.

• Workshops
• StudyWise
• Academic Integrity Module for Students
• Ask a Learning Adviser

**Student Enquiry Service**

For all student enquiries, visit Student Connect at ask.mq.edu.au

If you are a Global MBA student contact globalmba.support@mq.edu.au

**Equity Support**

Students with a disability are encouraged to contact the Disability Service who can provide appropriate help with any issues that arise during their studies.
IT Help

For help with University computer systems and technology, visit [http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/](http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/).

When using the University's IT, you must adhere to the [Acceptable Use of IT Resources Policy](http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/). The policy applies to all who connect to the MQ network including students.

**Graduate Capabilities**

**Discipline Specific Knowledge and Skills**

Our graduates will take with them the intellectual development, depth and breadth of knowledge, scholarly understanding, and specific subject content in their chosen fields to make them competent and confident in their subject or profession. They will be able to demonstrate, where relevant, professional technical competence and meet professional standards. They will be able to articulate the structure of knowledge of their discipline, be able to adapt discipline-specific knowledge to novel situations, and be able to contribute from their discipline to inter-disciplinary solutions to problems.

This graduate capability is supported by:

**Learning outcomes**

- Knowledge of the principles and concepts of a basic theory of Ordinary Differential Equations and the theory of Special Functions.
- Ability to use the ideas and techniques of the theory of Ordinary Differential Equations and the theory of the Special Functions to model a broad range of phenomena in science and in engineering.
- Ability to construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning.
- Expressing yourself clearly and logically in writing.

**Assessment tasks**

- 2 assignments
- One Test
- Exam

**Problem Solving and Research Capability**

Our graduates should be capable of researching; of analysing, and interpreting and assessing data and information in various forms; of drawing connections across fields of knowledge; and they should be able to relate their knowledge to complex situations at work or in the world, in order to diagnose and solve problems. We want them to have the confidence to take the initiative in doing so, within an awareness of their own limitations.
This graduate capability is supported by:

**Learning outcomes**

- Ability to use the ideas and techniques of the theory of Ordinary Differential Equations and the theory of the Special Functions to model a broad range of phenomena in science and in engineering.
- Ability to construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning.

**Assessment tasks**

- 2 assignments
- One Test
- Exam

**Effective Communication**

We want to develop in our students the ability to communicate and convey their views in forms effective with different audiences. We want our graduates to take with them the capability to read, listen, question, gather and evaluate information resources in a variety of formats, assess, write clearly, speak effectively, and to use visual communication and communication technologies as appropriate.

This graduate capability is supported by:

**Learning outcomes**

- Knowledge of the principles and concepts of a basic theory of Ordinary Differential Equations and the theory of Special Functions.
- Ability to use the ideas and techniques of the theory of Ordinary Differential Equations and the theory of the Special Functions to model a broad range of phenomena in science and in engineering.
- Ability to construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning.
- Expressing yourself clearly and logically in writing.

**Assessment tasks**

- 2 assignments
- One Test
- Exam

**Capable of Professional and Personal Judgement and Initiative**

We want our graduates to have emotional intelligence and sound interpersonal skills and to
demonstrate discernment and common sense in their professional and personal judgement. They will exercise initiative as needed. They will be capable of risk assessment, and be able to handle ambiguity and complexity, enabling them to be adaptable in diverse and changing environments.

This graduate capability is supported by:

**Assessment tasks**

- 2 assignments
- One Test
- Exam

**Critical, Analytical and Integrative Thinking**

We want our graduates to be capable of reasoning, questioning and analysing, and to integrate and synthesise learning and knowledge from a range of sources and environments; to be able to critique constraints, assumptions and limitations; to be able to think independently and systemically in relation to scholarly activity, in the workplace, and in the world. We want them to have a level of scientific and information technology literacy.

This graduate capability is supported by:

**Learning outcomes**

- Knowledge of the principles and concepts of a basic theory of Ordinary Differential Equations and the theory of Special Functions.
- Ability to use the ideas and techniques of the theory of Ordinary Differential Equations and the theory of the Special Functions to model a broad range of phenomena in science and in engineering.
- Ability to construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning.
- Expressing yourself clearly and logically in writing.

**Assessment tasks**

- 2 assignments
- One Test
- Exam

**Creative and Innovative**

Our graduates will also be capable of creative thinking and of creating knowledge. They will be imaginative and open to experience and capable of innovation at work and in the community. We want them to be engaged in applying their critical, creative thinking.

This graduate capability is supported by:
Learning outcomes

• Ability to use the ideas and techniques of the theory of Ordinary Differential Equations and the theory of the Special Functions to model a broad range of phenomena in science and in engineering.
• Ability to construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning.

Assessment tasks

• 2 assignments
• One Test
• Exam

Engaged and Ethical Local and Global citizens

As local citizens our graduates will be aware of indigenous perspectives and of the nation's historical context. They will be engaged with the challenges of contemporary society and with knowledge and ideas. We want our graduates to have respect for diversity, to be open-minded, sensitive to others and inclusive, and to be open to other cultures and perspectives: they should have a level of cultural literacy. Our graduates should be aware of disadvantage and social justice, and be willing to participate to help create a wiser and better society.

This graduate capability is supported by:

Learning outcomes

• Knowledge of the principles and concepts of a basic theory of Ordinary Differential Equations and the theory of Special Functions.
• Ability to use the ideas and techniques of the theory of Ordinary Differential Equations and the theory of the Special Functions to model a broad range of phenomena in science and in engineering.
• Expressing yourself clearly and logically in writing.

Socially and Environmentally Active and Responsible

We want our graduates to be aware of and have respect for self and others; to be able to work with others as a leader and a team player; to have a sense of connectedness with others and country; and to have a sense of mutual obligation. Our graduates should be informed and active participants in moving society towards sustainability.

This graduate capability is supported by:

Learning outcomes

• Knowledge of the principles and concepts of a basic theory of Ordinary Differential Equations and the theory of Special Functions.
Commitment to Continuous Learning

Our graduates will have enquiring minds and a literate curiosity which will lead them to pursue knowledge for its own sake. They will continue to pursue learning in their careers and as they participate in the world. They will be capable of reflecting on their experiences and relationships with others and the environment, learning from them, and growing - personally, professionally and socially.

This graduate capability is supported by:

Learning outcomes

• Knowledge of the principles and concepts of a basic theory of Ordinary Differential Equations and the theory of Special Functions.
• Ability to use the ideas and techniques of the theory of Ordinary Differential Equations and the theory of the Special Functions to model a broad range of phenomena in science and in engineering.
• Ability to construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning.
• Expressing yourself clearly and logically in writing.