

## COURSE OUTLINE: MH4911

Course Title	<b>Undergraduate Research Experience in Mathematical Sciences II</b>		
Course Code	<b>MH4911</b>		
Offered	Study Year 3, Semester T1		
Course Coordinator	Ng Keng Meng (Assoc Prof)	kmng@ntu.edu.sg	6513 8656
Pre-requisites	MH4910 or Approval by Division of Mathematical Sciences		
AU	4		
Contact hours	Lectures: 25		
Approved for delivery from	AY 2020/21 - Special Term I		
Last revised	2 Dec 2020, 08:28		

### Course Aims

This module is the follow-up to the module MH4910, and is offered to undergraduate students who are either continuing the research project started in MH4910, or who are interested in pursuing a different research topic.

The module provides you with the opportunity to work with a supervisor in a specific topic in mathematics. You will have the chance to be exposed to mathematical research during your undergraduate studies. It allows you to develop your mathematical maturity and to sharpen your analytical skills. It also provides you with the platform to develop research competencies that can lead to a final year project, and to provide invaluable practical research skills that can support your future career.

### Intended Learning Outcomes

Upon successfully completing this course, you should be able to:

1. Perform literature review in a selected mathematical research topic; summarize and link together different research findings
2. Apply knowledge from the findings to solve problems in a research setting, and develop creative and novel approaches
3. Identify and determine the requirements and demands of mathematical research
4. Develop methodologies and plans to achieve research objectives and outcomes
5. Work independently to solve research problems
6. Use the appropriate tools (including mathematical software and programming skills) to analyse and solve problems
7. Deal confidently with the ambiguity and anxiety that often comes with original research
8. Deliver advanced research findings in the selected research topic

### Course Content

In this research module, you (as a student) will experience independent supervised research work in a selected field of study. You will be supervised by a faculty from the Division of Mathematical Sciences to achieve the intended learning outcomes listed above. The specific content is dependent on the selected field of study.

## Assessment

Component	Course ILOs tested	SPMS-MAS Graduate Attributes tested	Weighting	Team / Individual	Assessment Rubrics
<b>Continuous Assessment</b>					
<b>Lectures</b>					
Final Oral Presentation	1, 2, 3, 4, 5, 6, 7, 8	1. a, b, c, d 2. a, b, c, d 3. a 4. a 5. a	40	individual	See Appendix for rubric
Continuous Assessment	1, 2, 3, 4, 5, 6, 7, 8	3. a 4. a 5. a	10	individual	See Appendix for rubric
Final Report	1, 2, 3, 4, 5, 6, 7, 8	1. a, b, c, d 2. a, b, c, d 3. a 4. a 5. a	50	individual	See Appendix for rubric
<b>Total</b>			<b>100%</b>		

These are the relevant SPMS-MAS Graduate Attributes.

### 1. Competence

- a. Independently process and interpret mathematical theories and methodologies, and apply them to solve problems
- b. Formulate mathematical statements precisely using rigorous mathematical language
- c. Discover patterns by abstraction from examples
- d. Use computer technology to solve problems, and to communicate mathematical ideas

### 2. Creativity

- a. Critically assess the applicability of mathematical tools in the workplace
- b. Build on the connection between subfields of mathematics to tackle new problems
- c. Develop new applications of existing techniques
- d. Critically analyse data from a multitude of sources

### 3. Communication

- a. Present mathematics ideas logically and coherently at the appropriate level for the intended audience

### 4. Civic-mindedness

- a. Develop and communicate mathematical ideas and concepts relevant in everyday life for the benefits of society

### 5. Character

- a. Act in socially responsible and ethical ways in line with the societal expectations of a mathematics professional, particularly in relation to analysis of data, computer security, numerical computations and algorithms

## Formative Feedback

Continuous feedback on progress and performance will be given by your supervisor throughout the semester.

## Learning and Teaching Approach

<b>Lectures</b> (25 hours)	<p>This course is an opportunity for you to experience first-hand mathematics research done in a professional setting. You are expected to be independent, disciplined and motivated. You will have to acquire the necessary background by conducting a literature review and undertaking reading of relevant materials. You will also be trained in developing problem-solving skills and creative methods to solve the problems given to you. You are expected to explore an advanced topic in mathematics and learn about the various problems, results and techniques in that area.</p> <p>The MAS Faculty Supervisor will be the key person working with and interacting with you on a regular basis. You are expected to take the initiative to approach your supervisor for discussions and resolve issues when you encounter difficulties.</p>
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## Reading and References

Reading materials are dependent on the selected field of study and specific to each project. Faculty Supervisor will recommend reading materials, and you will conduct a comprehensive literature review as well.

## Course Policies and Student Responsibilities

You are expected to be consistent in your work and assigned reading. You are also expected to learn the materials independently, and to develop creative problem solving skills. Depending on the project and the selected area of mathematics, you may be asked to code and run programs, learn advanced mathematical techniques or work on problems in the area. You are expected to uphold the principles of research and academic integrity and to the NTU Honour Code at all times. You should work independently and avoid plagiarizing, and give proper citations and credit for any results you use in your work.

## Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the [Academic Integrity website](#) for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

## Course Instructors

Instructor	Office Location	Phone	Email
Ng Keng Meng (Assoc Prof)	MAS-05-09	6513 8656	kmng@ntu.edu.sg

## Planned Schedule

Topic	Course ILO	Readings/ Activities
Weeks 1-10: Student will experience independent supervised research work in a selected field of study. Student will be supervised by the faculty from the Division of Mathematical Sciences to achieve the intended learning outcomes listed above. The specific content is dependent on the selection field of study	1, 2, 3, 4, 5, 6, 7	Assigned by the supervisor

## Appendix 1: Assessment Rubrics

### Rubric for Lectures: Final Oral Presentation (40%)

Grading Criteria	Exceptional (36-40)	Effective (30-35)	Acceptable (24-29)	Developing (0-23)
Accuracy	The interpretation is highly accurate, concise and precise.	The interpretation is mostly accurate. Some parts can be better explained or more succinct.	The interpretation is somewhat accurate. However, it contains some inaccuracies, missing points or ideas that are not related to the interpretation.	The interpretation are mostly inaccurate.
Visual and Oral delivery	Slides are informative, good clear voice and constant eye contact	Slides are adequate, oral delivery is satisfactory and frequent eye contact	Slides are bare and somewhat disorganized, voice is sometimes inaudible and little eye contact	Slides are disorganized, voice is too soft, and no eye contact
Presentation	Very clear and organized. It is easy to follow your train of thought	Mostly clear and organized. Some parts can have better transitions.	Somewhat clear. It requires some careful reading to understand what you are writing.	Mostly unclear and messy. It is difficult to understand what you are writing as there is no clear flow of ideas.
Question and Answer (for each individual student)	Very clear and precise answers to all problems. Explain the problems from various different perspectives logically.	Correct answers to most of the problems. Explain the problems in an organized way.	Partially-correct answers to most of the problems. Explain the some of the problems .	Unclear and messy answers. Difficult to understand.

## Rubric for Lectures: Continuous Assessment (10%)

Category	Scoring Criteria	Exceptional (8-10)	Satisfactory (5-7)	Developing (0-4)
<b>Initiative and Motivation</b>	Did the student appear motivated to complete the tasks assigned to him/her?	Very Motivated	Occasional display of enthusiasm	Disinterested in tasks and often procrastinates
	Did the student proactively clarify doubts with his/her supervisor?)	Often clarifies	Sometimes clarifies	Seldom clarifies
<b>Practical Ability and Creativity</b>	Did the student complete his/her assigned tasks satisfactorily?	Completes all tasks well	Completes some tasks	Does not complete most tasks
	Did the student expect supervisor input for simple problems?	Works independently	Occasionally expects supervisor input	Relies excessively on supervisor even for simple tasks
<b>Personal Discipline and Professionalism</b>	Did the student have integrity and a good management scheme for the data and calculations done for the project?	Well organized with handling data and is careful with quoting sources	Sometimes gets data mixed up	Disorganised and does not keep track of data. Copies from other sources without giving proper credit
	Is the student neat, responsible and focused to complete his/her work professionally?	Upholds strict professionalism	Satisfactory	Is often sloppy and does not display responsibility

## Rubric for Lectures: Final Report (50%)

Category	Scoring Criteria	Exceptional (40-50)	Satisfactory (30-39)	Developing (0-29)
<b>Organization</b>	Materials are organized and presented in a clear, coherent and logical sequence. Sharp sense of beginning and end	Well-organised	Some parts of the report are disorganised	Disorganised and incoherent
	Correct use of referencing throughout, formatted in the correct scientific specification.	Most references are used correctly	Some missing references or incorrectly used	Many missing references and incorrect usage
<b>Content</b>	Clear description of project's objectives, motivations, interpretation and explanation of research approach, process and findings.	Good, succinct and clear descriptions	Satisfactory descriptions	Unclear descriptions, missing interpretations or confusing presentation
	Technical terms are well-defined in language appropriate for the area.	Well-defined	Mostly well-defined	Poorly defined or many missing definitions
	Material included is accurate and relevant to the overall message/purpose.	Accurate and relevant	Some inaccuracies or redundant materials	Many inaccurate and irrelevant material
	Discussion and conclusions tie well with the problem statement and results obtained.	Good relation between discussion and conclusions	Some missing connections between discussion and conclusions	Missing or weak links between discussion, conclusions and results obtained
	Shows clear understanding of key concepts/theories.	Good understanding	Mostly demonstrates good understanding	Weak understanding of concepts
	Strong links made between problem statement, claims made, tools used and results.	Good links	Some missing links	Mostly missing links
<b>Originality</b>	Is the project a new initiative, or is it similar to a previous or ongoing project?	Mostly original	Some original parts	Little or no original material
	Does the project involve very sophisticated theory or does it require heavy and challenging code development?	Technically challenging	Satisfactory level of difficulty	Project is too easy with little original contributions
	Did the report contain original models or original results, novel and creative application of existing techniques/discovery of new principles?	Many novelties and original approaches	Some ingenuity can be observed	Little or no creativity