

**MATH4994 Capstone Project in Mathematics and Economics**  
**Course Outline**  
**Fall Semester 2025-2026**

**1. Instructor**

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Office hours: Every Friday 6:00p.m.- 7:30p.m.

**2. Meeting time and Venue**

Lectures: (Tues) 12:00p.m.-1:20p.m. @ Room 2463

(Thurs) 12:00p.m.-1:20p.m. @ Room 2463

(\*There is no attendance requirement for this course. However, you are expected to attend the face-to-face classes.)

**3. Course Description**

**Credit point:** 3 credits

This course provides MAEC students an opportunity to integrate and apply mathematical tools to analyze problems in economics and social science. More precisely, we shall cover matching schemes, voting methods and social choice theory and apportionment schemes. We shall study the model formulation and mathematical methods used for analyzing these problems. Next, each student needs to study some technical papers related to these topics and write a report.

**4. Intended Learning Outcome (ILOs)**

Upon successful completion of this course, students should be able to

- Appreciate how to use quantitative tools to analyse issues related to various mathematical models in economics and social science, including fair allocation, voting methods and proportional representation.
- Recognize the importance of applying rigorous and numerate approach to analyse and solve problem in economics and social science.
- Apply mathematical modelling and analytic proofs to describe and explain phenomena in economics and social science.
- Communicate the solutions of mathematical models of economics and social science using mathematical terminology through written reports.

## 5. Student Learning Resources

We will use our own Lecture notes (written by former instructor, Prof. Kwok Yue Kuen) in this course. Additional problem sets (optional) will be provided. The materials can be downloaded from <https://canvas.ust.hk> once they are available.

The following reference books will be useful:

1. Taylor, A.D., Pacelli, A.M., 2008, "Mathematics and Politics", 2<sup>nd</sup> edition, Springer.  
(\*You can download an e-copy from HKUST library.)

## 6. Teaching and Learning Activities

Lectures (3 hours per week)

## 7. Tentative Course Schedules (subject to change depending on teaching progress)

### Chapter 1: Fair allocations and allocation schemes (Topic 1 of the lecture)

- Criterion for fair divisions (or fair allocations)
- Procedures for multi-players resource allocation (cake-cutting)
  - Discrete cut-and-choose procedures
  - Continuous moving-knife procedures
- Adjusted winner procedures

### Chapter 2: Matching schemes (Topic 2 of lecture note)

- Marriage Problem
- College admission and school choice problems
  - Gale-Shapley student optimal stable mechanism
  - Top trading cycles mechanism
  - Boston school choice mechanism
- House allocation with existing tenants
- Roommate problems and Irving algorithm

### Chapter 3: Social Choice Theory (Topic 3 of lecture note, if time allowed)

- Social choice procedures and some examples
- Desirable properties of voting methods
- Condorcet voting methods
- Social welfare functions and some desirable properties for social welfare functions
- Arrow impossibility theorem

## 8. Assessment Scheme

### 1. Written assignments (10% of overall total)

### 2. Mini Course Project and Presentation (35% of overall total)

Students will form a group of 2 students and study research paper(s) related to the course content (\*See remarks). The topics will be announced by the instructor in end of September. Each group will need to study the research paper(s), write a written report and do in-class oral presentation. The tentative schedule is as follows:

Date	Events
End of September (In end Sept)	The instructor will announce the project titles available for course project in canvas.
12 <sup>th</sup> Oct, 2025	The students submit the group lists and project titles through canvas system
Before 17 <sup>th</sup> Nov, 2025	Each group needs to submit the preliminary draft of the written project in canvas
18 <sup>th</sup> -27 <sup>th</sup> Nov, 2025 (in class)	Each group will do oral presentation on their project during class hours (No lectures during these 2 weeks)
Before 6 <sup>th</sup> Dec, 2025	Each group will submit the final version of their written project in canvas.

\*Remarks: You are encouraged to work as a group of 2 for group project. However, you are allowed to work individually.

### 3. Final examination (55% overall total)

It is 2-2.5 hours closed books written examination. The exams will cover the materials taught in the lectures. The exact date of the examination will be announced by ARRO.

### Grading criterion

We will adopt criterion-referencing scheme when assigning your final grade: Your final grade will be assigned based on your overall performance in this course only.

- You are guaranteed to pass the course if you obtain at least **40%** in overall total (including bonus score) and at least **20** points (out of 100) in final examination.

Grade Descriptors:

Letter Grades	Short Description	Elaboration of subject grading description
A+/A/A-	Excellent Performance	The student has an excellent understanding on various topics related to social choice theory. In addition, the student managed to execute some researches related to social choice theory and may be able to raise some original ideas on those topics.

B+/B/B-	Good Performance	The student has a good understanding on various topics related to social choice theory. The student managed to do some preliminary researches related to social choice theory.
C+/C/C-	Satisfactory Performance	The student has limited understanding on social choice theory. The student is able to do some preliminary and very limited research work on social choice theory.
D	Marginal Pass	The student only know some very basic concepts in social choice theory. He may not be able to do any research on the social choice theory.
F	Fail	The student has very little understanding on social choice theory and failed to execute research on social choice theory.