

# MATH4824A – Mathematical Models in Economics and Finance

## Course outline – Spring 2014

### 1. Instructor

*Name: Professor Yue Kuen KWOK*

*Contact details: Office Room 3445, Tel: 2358-7418; E-mail: maykwok*

### 2. Teaching assistant

*Name: Jingjing Wang*

*Contact details: Office Room 3474, Tel: 2358-7453; E-mail: maariel*

### 3. Meeting time and Venue

*Date / time: Tuesday and Thursday (9:00am – 10:20am)*

*Venue: Room 6602*

### 4. Course description

*Credit points: 3*

*Pre-requisite: MATH2111 and MATH2411*

*Exclusion: Nil*

This course illustrates the use of mathematical techniques to analyze several quantitative models in economics and finance. The first part considers the quantitative analysis of voting systems and apportionment problems in social choice theory. The topics include: apportionment of legislature seats, proportional representation, measure of political power in voting systems, power indexes and analysis of electoral systems. The second part considers the Fundamental Theorem of Asset Pricing in Financial. The financial economics topics include: law of one price, notion of arbitrage, risk neutral valuation principle.

### 5. Intended learning outcomes

Upon the completion of the course, students should be able to:

- Appreciate how to use quantitative tools to analyze issues related to achieving fair representation in voting systems.
- Recognize the importance of applying rigorous and numerate approach to analyze and solve problem in social choice theory.
- Apply mathematical modeling and analytic proofs, as well as statistical analyses, to describe and explain phenomena in voting theory.
- Communicate the solutions of mathematical models of voting theory and apportionment using mathematical terminology and English language.

### 6. Assessment scheme

One 80-minute test	40%
120-minute final examination	60%

3 sets of homework

0%

Proper submission of all homework sets may help improve a minor grade on marginal cases.

*Date of mid-term test:* 20 March (Thursday) during the lecture hour

## 7. Student Learning Resources

*Textbook:* "Mathematics and Politics," A.D. Taylor and A.M. Pacelli, second edition (2008) Springer. The text can be downloaded from the HKUST Library <http://www.springerlink.com/content/p15061/>

## 8. Teaching and Learning Activities

Scheduled activities: 3 hours of lecture per week

## 9. Course Schedule

*Week 1 – Week 4*

### 1. Proportional representation and apportionment

- 1.1 General issues of apportionment of legislature seats
- 1.2 Quota method of the Greatest Remainder (Hamilton's method) and paradoxes
- 1.3 Geometric characterization and appointment simplex
- 1.4 Divisor methods
- 1.5 Huntington's family: pairwise comparison of inequity
- 1.6 Analysis of bias and notion of marginal inequity measure
- 1.7 Cumulative voting and proportional representation
- 1.8 Fair majority voting – eliminate Gerrymandering
- 1.9 Proportionality in matrix apportionment

*Week 4 – Week 8*

### 2. Analysis of powers in voting systems

- 2.1 Weighted voting systems and yes-no systems
- 2.2 Power indexes: Shapley-Shubik index and Banzhaf index
- 2.3 Case studies of power indexes calculations
- 2.4 Probabilistic characterization of power indexes
- 2.5 Potential blocs, quarreling paradoxes and bandwagon effects
- 2.6 Power distribution in weighted voting systems
- 2.7 Incomparability and desirability

*Week 9 – Week 12*

### 3. Fundamental theorem of asset pricing

- 3.1 Law of one price and Arrow securities
- 3.2 No-arbitrage theory and risk neutral probability measure
- 3.3 Valuation of contingent claims