Module name: DISCRETE MODELS OF FINANCIAL MARKETS
Academic year: 2015/2016  Code: AMA-2-078-BS-s  ECTS credits: 5
Faculty of: Applied Mathematics
Field of study: Mathematics  Specialty: (bez wyboru specjalności)
Study level: Second-cycle studies  Form and type of study: Full-time studies
Lecture language: English  Profile of education: Academic (A)  Semester: 0
Course homepage: 
Responsible teacher: dr Capiński Maciej (mcapinsk@agh.edu.pl)
Academic teachers: dr Capiński Maciej (mcapinsk@agh.edu.pl)  prof. nadzw. dr hab. Kobak Piotr (kobak@agh.edu.pl)

### Description of learning outcomes for module

<table>
<thead>
<tr>
<th>MLO code</th>
<th>Student after module completion has the knowledge/ knows how to/is able to</th>
<th>Connections with FLO</th>
<th>Method of learning outcomes verification (form of completion)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Social competence</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M_K001</td>
<td>The student will understand the limitations of mathematical models and the difficulties in making financial mathematics models relevant to real markets.</td>
<td>MA2A_U08, MA2A_U15</td>
<td>Activity during classes, Examination</td>
</tr>
<tr>
<td><strong>Skills</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M_U001</td>
<td>The student will be able to use the CRR model to price basic derivatives (European/American calls and puts).</td>
<td>MA2A_U10, MA2A_U16</td>
<td>Activity during classes, Examination</td>
</tr>
<tr>
<td><strong>Knowledge</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M_W001</td>
<td>The student will know how the basic properties of option prices follow from the &quot;no arbitrage formula&quot;</td>
<td>MA2A_W01, MA2A_W04, MA2A_W07, MA2A_U03, MA2A_U14</td>
<td>Activity during classes, Examination</td>
</tr>
<tr>
<td>M_W002</td>
<td>The student will know how the &quot;no arbitrage&quot; principle can be used to derive pricing formulae in discrete markets for basic derivatives.</td>
<td>MA2A_U01, MA2A_U03, MA2A_U14</td>
<td>Activity during classes, Examination</td>
</tr>
</tbody>
</table>
### Module card - DISCRETE MODELS OF FINANCIAL MARKETS

#### FLO matrix in relation to forms of classes

<table>
<thead>
<tr>
<th>MLO code</th>
<th>Student after module completion has the knowledge/ knows how to/is able to</th>
<th>Form of classes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lectures</td>
</tr>
<tr>
<td>M_K001</td>
<td>The student will understand the limitations of mathematical models and the difficulties in making financial mathematics models relevant to real markets.</td>
<td>+</td>
</tr>
<tr>
<td>M_U001</td>
<td>The student will be able to use the CRR model to price basic derivatives (European/American calls and puts).</td>
<td>+</td>
</tr>
<tr>
<td>M_W001</td>
<td>The student will know how the basic properties of option prices follow from the &quot;no arbitrage formula&quot;</td>
<td>+</td>
</tr>
<tr>
<td>M_W002</td>
<td>The student will know how the &quot;no arbitrage&quot; principle can be used to derive pricing formulae in discrete markets for basic derivatives.</td>
<td>+</td>
</tr>
</tbody>
</table>

#### Social competence

**M_K001**
- The student will understand the limitations of mathematical models and the difficulties in making financial mathematics models relevant to real markets.

#### Skills

**M_U001**
- The student will be able to use the CRR model to price basic derivatives (European/American calls and puts).

#### Knowledge

**M_W001**
- The student will know how the basic properties of option prices follow from the "no arbitrage formula".

**M_W002**
- The student will know how the "no arbitrage" principle can be used to derive pricing formulae in discrete markets for basic derivatives.

### Module content

#### Lectures

1. Binomial model in one step, the concept of the portfolio, the absence of arbitrage, the valuation by replication, uniqueness of martingale measure and its application to the valuation of derivative securities.

2. Trinomial model as the simplest example of incomplete market, the range of prices determined by the family of martingale measures, sub and super-replicating strategies.

3. Supplementing the model by adding assets. Condition for completeness in the language of the matrix of prices. Range of prices of derivatives linked to the supplemented market.

4. Many steps. The concept of strategy as a predictable process, the value strategy. Self-financing strategies, necessary and sufficient condition. Discounted prices and strategies. Admissible strategies, the principle of no arbitrage.

5. Binomial model, the valuation of European options. Application of the concept.
martingale in binomial model with a detailed description of filtration. Option price as an example of a martingale.


7. The first fundamental theorem in one step. Separation Lemma


9. Version of the theorem for multiple steps. The second fundamental theorem. Many assets, characterization of completeness by adjusting the number of degrees of freedom to the number of assets.

10. American option as Snell envelope. Stopping times, optimality.


12. Examples of optimal stopping times, theorems on maximal and minimal times.


14. Futures in binomial trees, exotic options.

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**Method of calculating the final grade**

written and oral exam

**Prerequisites and additional requirements**

Prerequisites and additional requirements not specified

**Recommended literature and teaching resources**


**Scientific publications of module course instructors related to the topic of the module**

3. Capiński, Maciej J.; Simó, Carles; Computer assisted proof for normally hyperbolic invariant manifolds; Nonlinearity 25, No. 7, 1997-2026 (2012).

**Additional information**

None
# Student workload (ECTS credits balance)

<table>
<thead>
<tr>
<th>Student activity form</th>
<th>Student workload</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participation in lectures</td>
<td>28 h</td>
</tr>
<tr>
<td>Realization of independently performed tasks</td>
<td>80 h</td>
</tr>
<tr>
<td>Examination or Final test</td>
<td>5 h</td>
</tr>
<tr>
<td>Contact hours</td>
<td>14 h</td>
</tr>
<tr>
<td>Summary student workload</td>
<td>127 h</td>
</tr>
<tr>
<td>Module ECTS credits</td>
<td>5 ECTS</td>
</tr>
</tbody>
</table>