AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Module name: DISCRETE MODELS OF FINANCIAL MARKETS

Academic year: 2019/2020 Code: AMAT-2-008-MI-s ECTS credits: 5

Faculty of: Applied Mathematics

Field of study: Mathematics Specialty: Mathematics in Computer Science

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 hab. Capiński Maciej (mcapinsk@agh.edu.pl)

Module summary

Discrete models of financial markets.

Description of learning outcomes for module

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Connections with FLO	Method of learning outcomes verification (form of completion)
Social competence: is able to			
M_K001	The student will understand the limitations of mathematical models and the difficulties in making financial mathematics models relevant to real markets.	MAT2A_U08, MAT2A_U15	Activity during classes, Examination
Skills: he can			
M_U001	The student will be able to use the CRR model to price basic derivatives (European/American calls and puts).	MAT2A_U10, MAT2A_U16	Activity during classes, Examination
Knowledge: he knows and understands			
M_W001	The student will know how the basic properties of option prices follow from the "no arbitrage formula"	MAT2A_U03, MAT2A_U14, MAT2A_W07, MAT2A_W01, MAT2A_W04	Activity during classes, Examination
M_W002	The student will know how the "no arbitrage" priciple can be used to derive pricing formulae in discrete markets for basic derivatives.	MAT2A_U03, MAT2A_U14, MAT2A_U01	Activity during classes, Examination

Number of hours for each form of classes

	Form of classes										
Suma	Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Prace kontrolne i przejściowe	Lektorat
30	30	0	0	0	0	0	0	0	0	0	0

FLO matrix in relation to forms of classes

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Form of classes										
		Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Prace kontrolne i przejściowe	Lektorat
Social competence: is able to												
M_K001	The student will understand the limitations of mathematical models and the difficulties in making financial mathematics models relevant to real markets.	+	-	-	-	-	-	-	-	-	-	-
Skills: he can												
M_U001	The student will be able to use the CRR model to price basic derivatives (European/American calls and puts).	+	-	-	-	-	-	-	-	-	-	-
Knowledge: he knows and understands												
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" priciple can be used to derive pricing formulae in discrete markets for basic derivatives.	+	-	-	-	-	-	-	-	-	-	-

Student workload (ECTS credits balance)

Student activity form	Student workload
Udział w zajęciach dydaktycznych/praktyka	30 h
Realization of independently performed tasks	88 h
Examination or Final test	2 h
Contact hours	5 h
Summary student workload	125 h
Module ECTS credits	5 ECTS

Additional information

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.

6. Markov property. Hedging against risk after issuing the option. Limit passage in the formula for the option price.

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

8. Martingale transform. Representation theorem in binomial model.

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.

11. Stopped processes, properties. Martingale properties of Snell envelope.

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

13. Doob decomposition and application to stopping times. American option pricin and hedging.

14. Futures in binomial trees, exotic options.

Teaching methods and techniques:

Lectures: Treści prezentowane na wykładzie są przekazywane w formie prezentacji multimedialnej w połączeniu z klasycznym wykładem tablicowym wzbogaconymi o pokazy odnoszące się do prezentowanych zagadnień.

Warunki i sposób zaliczenia poszczególnych form zajęć, w tym zasady zaliczeń poprawkowych, a także warunki dopuszczenia do egzaminu:

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Zasady udziału w poszczególnych zajęciach, ze wskazaniem, czy obecność studenta na zajęciach jest obowiązkowa:

Lectures:
– Attendance is mandatory: Yes
– Participation rules in classes: Studenci uczestniczą w zajęciach poznając kolejne treści nauczania zgodnie z syllabusem przedmiotu. Studenci winni na bieżąco zadawać pytania i wyjaśniać wątpliwości. Rejestracja audiowizualna wykładu wymaga zgody prowadzącego.

Method of calculating the final grade

written and oral exam

Sposób i tryb wyrównywania zaległości powstałych wskutek nieobecności studenta na zajęciach:

Student powinien zgłosić się do prowadzącego w celu ustalenia indywidualnego sposobu nadrobienia zaległości.

Prerequisites and additional requirements

Prerequisites and additional requirements not specified

Recommended literature and teaching resources

1) M.Capinski, T.Zastawniak, Discrete Models of Financial Markets, Cambridge University Press (2011)

2) M.Capinski, T.Zastawniak, Mathematics for Finance, Springer, London 2010.

3) S.Pliska, Introduction to Mathematical Finance. Discrete time models, Blackwell, Oxford 1997

4) R.Elliott, P.E.Kopp, Mathematics of Financial Markets, Springer 2006

5) S.Shreve, Stochastic Calculus for Finance I, The Binomial Asset Pricing Model, Springer 2004.2.

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

1. M.Capinski, T.Zastawniak, Mathematics for Finance, Springer, London 2010.

2. M.Capinski, T.Zastawniak, Discrete Models of Financial Markets, Cambridge University Press (2011)

3. M.J. Capiński, Hedging conditional value at risk with options : short communication , European Journal of Operational Research (2015) vol. 242 iss. 2, s. 688–691.

4. M.J. Capiński, P.E. Kopp, Portfolio Theory and Risk Management, Cambridge University Press (2014)

5. Capiński, Maciej; Zastawniak, Tomasz;
Numerical methods in finance with C++;
Mastering Mathematical Finance. Cambridge: Cambridge University Press (2012).

Additional information

None