# Syllabus

1. Course Description

a. Title of a Course: «Choice and Decision Theory»

b. Pre-requisites: basic courses in Calculus, Discrete Mathematics, Linear Algebra, Theory of Probability and Mathematical Statistics

c. Course Type (compulsory, elective, optional): compulsory

d. Abstract: The course includes main notions and stages of decision making, uni- and multicriterial models, rationality of individual and social decisions, main notions of utility theory, choice models, and their use in applied problems.

2. Learning Objectives: To familiarize students with the basic concepts, models and statements of the theory of choice and decision making.

3. Learning Outcomes:

- Know principles of models construction in decision analysis;
- Be able to choose rational options in practical decision-making problems;
- Have skills in analysis of game-theoretic models.

4. Course Plan:

| № | Topic | Total | Course format (in hours) | | self-study |
|---|---|---|---|---|---|
| | | | lecture | seminar | |
| 1 | Mathematical Model of the Decision Making Situation: Decision making, its participants and stages. Mathematical Theory of Measurement. | 14 | 2 | 2 | 10 |
| 2 | Utility, Preference and Choice. Utility function, value function. Binary relations of preference and indifference. Choice functions, their properties. Optimal and undominated alternatives. Context-dependent interval choice. | 32 | 4 | 6 | 20 |
| 3 | ~~Social Choice and Aggregation Models. Majority rule. Condorcet paradox. Arrow's Impossibility Theorem. Borda rule.~~ Internal and External stability. Core. Some rules: position rules, rules based on majority relation, rules based on auxiliary number scale, rules based on tournament matrix. Threshold aggregation rule. Superposition of choice rules. | 28 | 6 | 4 | 20 |

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|---|---|---|---|---|---|
| 4 | Networks. Main notions. Classic centrality measures. Short- and Long-Range Interaction. Centralities. Applications. | 18 | 4 | 4 | 10 |
| 5 | Political Decision Making. Downsian Analysis. Spatial Model of Voting. McKelvey's Theorem. Manipulation of agents. | 28 | 4 | 4 | 20 |
| 6 | Polarization in parliaments: uni- and multidimensional cases. Power distribution in electoral bodies. Classical power indices: Banzhaf index, Shapley-Shubik index, Johnston index, Deegan-Pakel index. Power indices taking into account agent's preferences to coalesce. Applications. | 28 | 4 | 4 | 20 |
| 7 | Assignment problem. Unicriterial assignment problem. Multicriterial assignment problem. Optimality criterion. Two-sided matchings. One-to-many matchings. Many-to-many matchings. Applications. | 42 | 6 | 6 | 30 |
| | Total | 190 | 30 | 30 | 130 |

5. Reading List

a. Required


1. Aleskerov F., Bouyssou D., Monjardet B. 'Utility Maximization, Choice and Preference', Springer Verlag, Berlin, 2007.
2. Aleskerov F. T. Arrovian Aggregation Models. Dordrecht : Kluwer Academic Publisher, 1999.
3. Fishburn P. Mathematics for Decision Theory, The Hague, Mouton, 1972 .
4. Aizerman M., Aleskerov F. Theory of Choice, Elsevier, 1995.
5. Luce R.D., Raiffa H. Games and Decisions, New York, Wiley, 1957.


b. Optional


1. Kreps D. Notes on the theory of choice, Westview Press / Boulder and London, Colorado USA, 1988, ISBN 0-8133-7553-3.
2. Aleskerov F. T., Meshcheryakova N. G., Sergeeva Z., Shvydun S. V. Centrality Measures And Clustering Analysis in a Retail Food Network, in: 2017 IEEE 11th International Conference on Application of Information and Communication Technologies / Ed. by Novikov D.A. Vol. 1. M.: Institute of Electrical and Electoronics Engineers, 2017. P. 48-52.
3. Aleskerov F. T., Meshcheryakova N. G., Rezyapova A., Shvydun S. V. Network Analysis of International Migration, in: Models, Algorithms, and Technologies for Network Analysis. Springer Proceedings in Mathematics & Statistics / Ed. by V. A.

Kalyagin, A. I. Nikolaev, P. M. Pardalos, O. Prokopyev. Vol. 197. Springer International Publishing, 2017. doi P. 177-185.

4. Aleskerov F. T., Meshcheryakova N. G., Shvydun S. V. Power in Network Structures, in: Models, Algorithms, and Technologies for Network Analysis. Springer Proceedings in Mathematics & Statistics / Ed. by V. A. Kalyagin, A. I. Nikolaev, P. M. Pardalos, O. Prokopyev. Vol. 197. Springer International Publishing, 2017.
5. Aleskerov F. T., Meshcheryakova N. G., Shvydun S. V., Yakuba V. I. Centrality Measures in Large and Sparse Networks, in: 6th International Conference on Computers Communications and Control (ICCCC) 2016. Oradea : Agora University, 2016. P. 118-123.
6. Aleskerov F., Avci G., Iacouba V., and Turem Z.U. ‘European Union enlargement: power distribution implications of the new institutional arrangements’, European Journal of Political Research, 41, 2002, 379-394.
7. Aleskerov F. ‘Power indices taking into account agents’ preferences’, in ‘Mathematics and Democracy’ (B.Simeone and F.Pukelsheim, eds.), Springer, Berlin, 2006, 1-18.
8. Aleskerov F. ’Power Indices Taking into Account the Agents' Preferences for Coalescence,’ Doklady Mathematics, 2007, v.75, №3/2.
9. Aleskerov F., Kalyagin V., Pogorelskiy K. ‘An analysis of power distribution in the International Monetary Fund’, Automation and Remote Control, 2008, no.11, pp. 140-148.
10. Fuad Aleskerov, Manfred J. Holler, Rita Kamalova. Power distribution in the Weimar Reichstag in 1919–1933, Annals of Operations Research. April 2014, Volume 215, Issue 1, pp 25-37.
11. Hinich M., Munger M. Analitical Politics. – Cambridge University Press, Cambridge, 1997.
12. Ordeshook P. A Political Theory Primer. - Routledge, NY, London, 1992.
13. Esteban, J., Ray, D. Polarization, fractionalization and conflict, Journal of Peace Research 45, 2008, pp. 163–182.
14. Aleskerov F. T., Oleynik V. Multidimensional Polarization Index and its Application to an Analysis of the Russian State Duma (1994 – 2003). HSE Working Papers WP7 "Mathematical methods of decision analysis in economics, business and politics". 2016.
15. Roth A., Sotomayor M.O. Two-sided matching, Cambridge University Press, 1990, Cambridge.
16. Alkan A. Nonexistence of stable threesome matchings, Mathematical Social Sciences, 1988, 16, pp. 207-209.
17. Gale D., Shapley L. College admissions and the stability of marriage. American Mathematical Monthly, 1962, 69, pp. 9-15.
18. Felsenthal D.S., Machover M. The Measurement of Voting Power: Theory and Practice, Problems and Paradoxes. Cheltenham: Edward Elgar, 1998, 322p.

6. Grading System

Cumulative grade = 50% homework + 50% mid-term exam

Final grade = 40% cumulative grade + 60% final exam

Rounding of the cumulative grade and final grade must be performed according to the rules of arithmetic. There is no possibility to get an extra point on the resit to compensate the low cumulative grade.

7. Guidelines for Knowledge Assessment

There is a homework consisting of 3 parts in the middle of the course. Students are encouraged to work together to help each other in understanding the course material and completing the homework problems. However, everybody has to write up his/her own solutions. Late homework will not be accepted. The common mistakes made in the homework will be discussed during the seminars.

Homework and exams consist of tasks that are equivalent or similar to those which have been studied at lectures and seminars. Any fact of cheating will result in receiving a "0" (zero) for this work.

8. Methods of Instruction

The discipline is delivered through lectures seminars, including computer classes.

9. Special Equipment and Software Support (if required): Computer classes