

SYLLABUS / FIȘA DISCIPLINEI
1. Information on the study programme / Date despre programul de studii

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| 1.1. Institution / Instituția de învățământ superior | Universitatea de Vest din Timișoara |
| 1.2. Faculty / Facultatea | Matematică și Informatică |
| 1.3. Department / Departamentul | Computer Science (Informatică) |
| 1.4. Study program field | Computer Science (Informatică) |
| 1.5. Study cycle/ Ciclul de studii | Bachelor / licență |
| 1.6. Study programme / Programul de studii / calificarea* | Computer Science / Informatică în limba engleză / Database administration / <i>Administrator baze de date - 252101; Computer network administration / Administrator de rețea de calculatoare - 252301; Analyst / Analist - 251201; Research assistant in computer science / Asistent de cercetare în informatică - 214918; Teacher in secondary schools / Profesor în învățământul gimnazial - 233002; Programmer / Programator - 251202; Software systems designers / Proiectant sisteme informatice - 251101</i> |

2. Information on the course / Date despre disciplină

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|--|--------------------------------|---------------------------|---|---|---|--|----|
| 2.1. Title of the course / Denumirea disciplinei | Graph Theory and Combinatorics | | | | | | |
| 2.2. Teacher in charge of the course / Titularul activităților de curs | Isabela Drămnesc | | | | | | |
| 2.3. Teacher in charge of the seminar / Titularul activităților de seminar | Isabela Drămnesc | | | | | | |
| 2.4. Study year / Anul de studii | 2 | 2.5. Semester / Semestrul | 1 | 2.6. Examination type / Tipul de evaluare: E(xam)/C(olloquim) | E | 2.7. Course type / Regimul disciplinei: M(andatory)/ E(lective)/ F(acultative) | DI |

3. Estimated study time (number of hours per semester) /Timpul total estimat (ore pe semestru al activităților didactice)

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| 3.1. Attendance hours per week / Număr de ore pe săptămână | 3 | out of which din care: 3.2 lecture/ curs | 2 | 3.3. seminar/laborator | 1 |
| 3.4. Attendance hours per semester / Total ore din planul de învățământ | 42 | out of which: 3.5 lecture / curs | 28 | 3.6. seminar/laborator | 14 |
| Distribution of the allocated amount of time / Distribuția fondului de timp* | | | | | hours/ ore |
| Individual study /Studiu după manual, suport de curs, bibliografie și notițe | | | | | 33 |
| Supplementary documentation at library or using electronic repositories / Documentare suplimentară în bibliotecă, pe platformele electronice de specialitate | | | | | 14 |
| Preparing for laboratories, homework, reports etc. /Pregătire seminarii/laboratoare, teme, referate, portofolii și eseuri | | | | | 33 |
| Exams / Examinări | | | | | 6 |

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| Tutoring / Tutorat | | 7 |
| 3.7. Total number of hours of individual study / Total ore studiu individual | 93 | |
| 3.8. Total number of hours per semester / Total ore pe semestru | 135 | |
| 3.9. Number of credits (ECTS) / Număr de credite | 5 | |

4. Prerequisites (if it is the case) / Precondiții (acolo unde e cazul)

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| 4.1. curriculum / de curriculum | Not the case/Nu e cazul |
| 4.2. skills / de competențe | Mathematics basis and the ability to solve problems / Cunoștințe elementare de matematica și abilități de rezolvarea a problemelor |

5. Requirements (if it is the case) / Condiții (acolo unde e cazul)

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| 5.1. for the lecture / de desfășurare a cursului | Access to Google Meet, Google Classroom, videoprojector, laptop, graphical tablet/ Acces la Google Meet, Google Classroom, videoprojector, laptop, tableta grafică |
| 5.2. for the seminar, laboratory / de desfășurare a seminarului/laboratorului | Access of Mathematica software (including the package Combinatorica) / Acces la softul Mathematica (incluzând pachetul Combinatorica) |

6. Acquired skills / Competențe specifice acumulate

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|---|---|
| Professional skills / Competențe profesionale | <ul style="list-style-type: none"> • Become familiar with basic combinatorics notions and principles: counting principles; permutations and combinations; enumeration and generation algorithms; cyclic structures of permutations; Polya's theory; partitions, compositions and generation algorithms; partitions of sets. / Familiarizare cu noțiunile și principiile de bază din combinatorică: principii de numărare; permutări și combinări; algoritmi de generare și enumerare; structuri ciclice de permutări; teoria lui Polya; partiții, compoziții și algoritmi de generare; partiții de mulțimi. • Combinatorial reasoning based on counting techniques / Răzămînt combinatorial bazat pe tehnici de numărare. • Become familiar with the basic notions from the graph theory: definitions, classifications; data structures for graphs and related operations; graph generations; eulerian and hamiltonian trails and circuits; matchings; |
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| | graph colorings; flow networks; planar graphs / Familiarizare cu notiunile de baza din teoria grafurilor: definitii, clasificari; structuri de date pentru grafuri si operatii aferente; generarea de grafuri; drumuri si cicluri euleriene si hamiltoniene; potriviri; colorarea grafurilor; acoperiri de noduri si multimi independente; potriviri; grafuri planare. |
| Transversal skills / Competențe transversale | <ul style="list-style-type: none"> • Problem modeling in various domains of interest using notions from combinatorics and graph theory and the application of algorithms and techniques presented for solving them / Modelarea problemelor din diverse domenii de interes usor folosind notiuni din combinatorica si teoria grafurilor si aplicarea algoritmilor si a tehnicilor prezentate pentru rezolvarea acestora. |

7. Objectives of the course / Obiectivele disciplinei (reieșind din grila competențelor specifice acumulate)

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| 7.1. General objective / Obiectivul general al disciplinei | Gaining fundamental knowledge in combinatorics and graph theory / Insusirea de cunostinte fundamentale in combinatorica si teoria grafurilor. |
| 7.2. Specific objectives / Obiectivele specifice | <ul style="list-style-type: none"> • <i>Learning objective/Ob. de cunoaștere (OC):</i> Learning to perform combinatorial reasoning using the principles and concepts presented in the lectures / Deprinderea de a efectua rationamente combinatoriale cu ajutorul principiilor si a notiunilor prezentate la curs. • <i>Ability objective/Ob. de abilitare (OAb):</i> The ability to model various problems using notions of combinatorics and graph theory, and also to solve them efficiently or using combinatorial reasoning techniques and algorithms from graph theory / Abilitatea de a modela probleme diverse folosind notiuni din combinatorica si teoria grafurilor si de a le rezolva eficient folosind rationament combinatorial sau tehnici si algoritmi din teoria grafurilor. • <i>Attitude objective/Ob. Atitudinale (OAt):</i> Experiments with the educational and research tool Combinatorica, working with graphs, partitions, permutations, and other combinatorial objects / Experimente cu instrumentul educational si de cercetare Combinatorica, pentru lucrul cu grafuri, partitii, permutari si alte obiecte combinatoriale. |

8. Content / Conținuturi*

| 8.1. Lecture / Curs | Teaching strategies / Metode de predare | Remarks, details / Observații |
|---|---|--|
| 1) Introduction. Counting Principles. Permutations and Combinations. Binomial and Multinomial Numbers (<i>OC, Oab, OAt</i>) | Lecture, conversation, illustration / Prelegere, conversatie, exemplificare | References/Referinte : 1. Isabela Drămnesc – lecture slides – http://staff.fmi.uvt.ro/~isabela.dramnesc 2. J.M. Harris, J.L. Hirst, M.J. Mossinghoff. Combinatorics and Graph Theory. Second Edition. Springer. 2008 |
| 2) Generating Permutations. Ranking and Unranking Permutations. The Pigeonhole Principle. The Inclusion and Exclusion Principle (<i>OC, Oab, OAt</i>) | Lecture, conversation, illustration / Prelegere, conversatie, exemplificare | References/Referinte : 1. Isabela Drămnesc – lecture slides – http://staff.fmi.uvt.ro/~isabela.dramnesc 2. J.M. Harris, J.L. Hirst, M.J. Mossinghoff. Combinatorics and Graph Theory. Second Edition. Springer. 2008 3. S. Pemmaraju, S. Skiena. Combinatorics and Graph Theory with Combinatorica. Cambridge University Press 2003 |
| 3) Permutations with repetition. Combinations. Enumeration, ranking and unranking algorithms (<i>OC, Oab, OAt</i>) | Lecture, conversation, illustration / Prelegere, conversatie, exemplificare | References/Referinte : 1. Isabela Drămnesc – lecture slides – http://staff.fmi.uvt.ro/~isabela.dramnesc 2. J.M. Harris, J.L. Hirst, M.J. Mossinghoff. Combinatorics and Graph Theory. Second Edition. Springer. 2008 3. S. Pemmaraju, S. Skiena. Combinatorics and Graph Theory with Combinatorica. Cambridge University Press 2003 |
| 4) The Cycle Structure of Permutations. Advanced Counting Techniques (<i>OC, Oab, OAt</i>) | Lecture, conversation, illustration / Prelegere, conversatie, exemplificare | References/Referinte : 1. Isabela Drămnesc – lecture slides – http://staff.fmi.uvt.ro/~isabela.dramnesc 2. J.M. Harris, J.L. Hirst, M.J. Mossinghoff. Combinatorics and Graph Theory. Second Edition. Springer. 2008 |
| 5) Polya theory (<i>OC, Oab, OAt</i>) | Lecture, conversation, illustration / Prelegere, | References/Referinte : |

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|---|---|--|
| | conversatie, exemplificare | <ol style="list-style-type: none"> 1. Isabela Drămnesc – lecture slides – http://staff.fmi.uvt.ro/~isabela.dramnesc 2. J.M. Harris, J.L. Hirst, M.J. Mossinghoff. Combinatorics and Graph Theory. Second Edition. Springer. 2008 |
| 6) Polya's enumeration formula. Stirling cycle numbers. Stirling set numbers (OC, Oab, OAt) | Lecture, conversation, illustration / Prelegere, conversatie, exemplificare | <p>References/Referinte :</p> <ol style="list-style-type: none"> 1. Isabela Drămnesc – lecture slides – http://staff.fmi.uvt.ro/~isabela.dramnesc 2. J.M. Harris, J.L. Hirst, M.J. Mossinghoff. Combinatorics and Graph Theory. Second Edition. Springer. 2008 3. S. Pemmaraju, S. Skiena. Combinatorics and Graph Theory with Combinatorica. Cambridge University Press 2003 |
| 7) Partial exam. | Lecture, conversation, illustration / Prelegere, conversatie, exemplificare | 1. |
| 8) Introduction to Graph Theory. Distance in Graphs. Trees (OC, Oab, OAt) | Lecture, conversation, illustration / Prelegere, conversatie, exemplificare | <p>References/Referinte :</p> <ol style="list-style-type: none"> 1. Isabela Drămnesc – lecture slides – http://staff.fmi.uvt.ro/~isabela.dramnesc 2. J.M. Harris, J.L. Hirst, M.J. Mossinghoff. Combinatorics and Graph Theory. Second Edition. Springer. 2008 3. S. Pemmaraju, S. Skiena. Combinatorics and Graph Theory with Combinatorica. Cambridge University Press 2003 |
| 9) Kinds of graphs. Data structures for graph representation. Connectivity. The naive algorithm and Warshall algorithm. Bipartite graphs (OC, Oab, OAt) | Lecture, conversation, illustration / Prelegere, conversatie, exemplificare | <p>References/Referinte :</p> <ol style="list-style-type: none"> 1. Isabela Drămnesc – lecture slides – http://staff.fmi.uvt.ro/~isabela.dramnesc 2. J.M. Harris, J.L. Hirst, M.J. Mossinghoff. Combinatorics and Graph Theory. Second Edition. Springer. 2008 3. S. Pemmaraju, S. Skiena. Combinatorics and Graph Theory with Combinatorica. Cambridge University Press 2003 |

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| <p>10) Flow Networks. Maximum flow algorithms. Applications and extensions (<i>OC, Oab, OAt</i>)</p> | <p>Lecture, conversation, illustration / Prelegere, conversatie, exemplificare</p> | <p>References/Referinte :</p> <ol style="list-style-type: none"> 1. Isabela Drămnesc – lecture slides – http://staff.fmi.uvt.ro/~isabela.dramnesc 2. J.M. Harris, J.L. Hirst, M.J. Mossinghoff. Combinatorics and Graph Theory. Second Edition. Springer. 2008 3. S. Pemmaraju, S. Skiena. Combinatorics and Graph Theory with Combinatorica. Cambridge University Press 2003 |
| <p>11) Eulerian trails and circuits. Hamiltonian paths and cycles (<i>OC, Oab, OAt</i>)</p> | <p>Lecture, conversation, illustration / Prelegere, conversatie, exemplificare</p> | <p>References/Referinte :</p> <ol style="list-style-type: none"> 1. Isabela Drămnesc – lecture slides – http://staff.fmi.uvt.ro/~isabela.dramnesc 2. J.M. Harris, J.L. Hirst, M.J. Mossinghoff. Combinatorics and Graph Theory. Second Edition. Springer. 2008 3. S. Pemmaraju, S. Skiena. Combinatorics and Graph Theory with Combinatorica. Cambridge University Press 2003 |
| <p>12) Matchings. Definitions. Hall's Theorem and SDRs. Perfect matchings. Spanning trees and minimum spanning trees. Prim's algorithm and Kruskal's algorithm (<i>OC, Oab, OAt</i>)</p> | <p>Lecture, conversation, illustration / Prelegere, conversatie, exemplificare</p> | <p>References/Referinte :</p> <ol style="list-style-type: none"> 1. Isabela Drămnesc – lecture slides – http://staff.fmi.uvt.ro/~isabela.dramnesc 2. J.M. Harris, J.L. Hirst, M.J. Mossinghoff. Combinatorics and Graph Theory. Second Edition. Springer. 2008 3. S. Pemmaraju, S. Skiena. Combinatorics and Graph Theory with Combinatorica. Cambridge University Press 2003 |
| <p>13) Planar graphs. Graph colorings. Chromatic polynomials (<i>OC, Oab, OAt</i>)</p> | <p>Lecture, conversation, illustration / Prelegere, conversatie, exemplificare</p> | <p>References/Referinte :</p> <ol style="list-style-type: none"> 1. Isabela Drămnesc – lecture slides – http://staff.fmi.uvt.ro/~isabela.dramnesc 2. J.M. Harris, J.L. Hirst, M.J. Mossinghoff. Combinatorics and Graph Theory. Second Edition. Springer. 2008 3. S. Pemmaraju, S. Skiena. Combinatorics and Graph Theory with Combinatorica. |

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| | | Cambridge University Press 2003 |
| 14) Revision (<i>Oab, OAt</i>) | Lecture, conversation, illustration / Prelegere, conversatie, exemplificare | References/Referinte : 1. Isabela Drămnesc – lecture slides – http://staff.fmi.uvt.ro/~isabela.dramnesc 2. J.M. Harris, J.L. Hirst, M.J. Mossinghoff. Combinatorics and Graph Theory. Second Edition. Springer. 2008 3. S. Pemmaraju, S. Skiena. Combinatorics and Graph Theory with Combinatorica. Cambridge University Press 2003 |
| Recommended bibliography / Bibliografie [1] Isabela Drămnesc – lecture slides – http://staff.fmi.uvt.ro/~isabela.dramnesc [2] Mircea Marin https://staff.fmi.uvt.ro/~mircea.marin [3] S. Pemmaraju, S. Skiena. Combinatorics and Graph Theory with Combinatorica. Cambridge University Press 2003 [4] http://www3.cs.stonybrook.edu/~skiena/combinatorica [5] J.M. Harris, J.L. Hirst, M.J. Mossinghoff. Combinatorics and Graph Theory. Second Edition. Springer. 2008 | | |
| 8.2. Seminar, lab / Seminar, laborator | Teaching/learning strategies / Metode de predare/ învățare | Remarks, details / Observații |
| 1) Exercises related to the first two lectures. | Questioning, dialogue, collaborative learning, problem based learning / Problematizare, dialog, învățare prin colaborare, învățarea bazată pe probleme | The students can access directly online the requests for the exercises (http://staff.fmi.uvt.ro/~isabela.dramnesc) and on Google Classroom. The teacher gives details/explains, answers to the students questions and checks/evaluates the way how the students have solved the exercises. / Studentii au acces la sinteza aferentă tematicii de laborator și la enunțurile problemelor recomandate spre rezolvare (http://staff.fmi.uvt.ro/~isabela.dramnesc). Cadrul didactic oferă detalii suplimentare, răspunde întrebărilor studenților și verifică/ evaluează modul în care studenții au rezolvat problemele. |
| 2) Exercises related to lecture three and four. Introduction to Mathematica (using the | Questioning, dialogue, collaborative learning, problem based learning / Problematizare, dialog, învățare prin | Idem |

| | | |
|--|--|------|
| Combinatorica package) | colaborare, învățarea bazată pe probleme | |
| 3) Exercises related to lecture five and six. The use of Mathematica (Combinatorica package) | Questioning, dialogue, collaborative learning, problem based learning / Problematizare, dialog, învățare prin colaborare, învățarea bazată pe probleme | Idem |
| 4) Exercises related to lecture seven and eight | Questioning, dialogue, collaborative learning, problem based learning / Problematizare, dialog, învățare prin colaborare, învățarea bazată pe probleme | Idem |
| 5) Exercises related to lecture nine and ten | Questioning, dialogue, collaborative learning, problem based learning / Problematizare, dialog, învățare prin colaborare, învățarea bazată pe probleme | Idem |
| 6) Exercises related to lecture eleven and twelve | Questioning, dialogue, collaborative learning, problem based learning / Problematizare, dialog, învățare prin colaborare, învățarea bazată pe probleme | Idem |
| 7) Revision | Questioning, dialogue, collaborative learning, problem based learning / Problematizare, dialog, învățare prin colaborare, învățarea bazată pe probleme | Idem |

Recommended bibliography / Bibliografie

[1] Isabela Drămnesc <http://staff.fmi.uvt.ro/~isabela.dramnesc>

[2] Mircea Marin <https://staff.fmi.uvt.ro/~mircea.marin>

[3] S. Pemmaraju, S. Skiena. Combinatorics and Graph Theory with Combinatorica. Cambridge University Press 2003

[4] <http://www3.cs.stonybrook.edu/~skiena/combinatorica>

[5] J.M. Harris, J.L. Hirst, M.J. Mossinghoff. Combinatorics and Graph Theory. Second Edition. Springer. 2008

9. Correlations between the content of the course and the requirements of the IT field / Coroborarea conținuturilor disciplinei cu așteptările reprezentanților comunității epistemice, asociațiilor profesionale și angajatorilor reprezentativi din domeniul aferent programului

The content is consistent with the structure of similar courses from other universities and covers the fundamental aspects necessary in order to become familiar with issues of designing and analysis of algorithms. The ability to identify, design, implement and analyze algorithms is essential for any activity in the field of computer science. The skills offered by this discipline are needed for an IT specialist to identify effective solutions for solving concrete problems, regardless of their industry. / Conținutul este în concordanță cu structura cursurilor similare de la alte universități și acoperă aspectele fundamentale necesare familiarizării cu problematica proiectării și analizei algoritmilor. Abilitatea de a identifica, proiecta, implementa și analiza algoritmi este esențială pentru orice activitate

din domeniul informaticii. Competențele oferite de această disciplină sunt necesare unui specialist IT pentru a identifica soluții eficiente de rezolvare a unor probleme concrete, indiferent de domeniul specific de activitate.

10. Evaluation / Evaluare*

| Activity / Tip de activitate | 10.1. Evaluation criteria / Criterii de evaluare** | 10.2. Evaluation methods / Metode de evaluare*** | 10.3. Weight in the averaged mark / Pondere din nota finală |
|--|---|---|---|
| 10.4. Lecture / Curs | 1) Learning the concepts presented in the first part of the lectures: Combinatorics / Insusirea conceptelor prezentate in prima parte a cursului: Combinatorica. (OC) 2) The application of the concepts and algorithms in concrete cases / Aplicatii ale conceptelor si algoritmilor prezentați in cazuri concrete. (OAb) | Written exam during the semester / Test scris pe parcursul semestrului | 25% |
| | 1) Learning the concepts presented in the second part of the lectures: Graph Theory / Insusirea conceptelor prezentate in a doua parte a cursului: Teoria Grafurilor. (OC) 2) The application of the concepts and algorithms in concrete cases /Aplicatii ale conceptelor si algoritmilor prezentați in cazuri concrete. (OAb) | Written exam during the examination period / Test scris in sesiunea de examene | 50% |
| 10.5. Seminar/ lab | Exercises related to the lectures / Exerciții referitoare la conținutul cursurilor predate (OAb, OAt) | Homework presented during the seminars + activity during the semester (oral assessment)/ Teme prezentate in timpul orelor de seminar+ activitate laborator (evaluare orala) | 25% |
| 10.6. Minimal knowledge for passing / Standard minim de performanță | | | |
| The final grade is calculated as a weighted average of the grades given for the components specified in 10.4 and 10.5. The exam is passed if the average is at least 5 (not necessary as each grade to be greater than 5). At each exam sessions the grade is calculated by the same rule. | | | |

Remark: The students may attend office hours (one hour / week according to the schedule set out at the beginning of the semester) where the teacher of the course and / or laboratory answers to the students questions and provides further explanations related to the course content, and to the applications from laboratories.

/ Nota finală se calculează ca medie ponderată a notelor acordate pentru componentele specificate la 10.4 și 10.5. Examenul se consideră promovat dacă media este cel puțin 5 (nu e necesar ca fiecare notă să fie mai mare de 5) . La fiecare dintre sesiunile de examen (inclusiv cele de restanță și măriri) nota se calculează după aceeași regulă.

Obs: Studenții pot participa la orele de consultații (1 modul/săptămână conform planificării stabilite la începutul semestrului) în cadrul cărora titularul de curs și/sau seminar/laborator răspunde întrebărilor studenților și oferă explicații suplimentare legate de conținutul cursului, aplicațiile de la laborator și teme.

Date/ Data completării
21.09.2020

Signature (lecture) /
Semnătura titularului de curs
Lect. Dr. Isabela Drămnesc

Signature (seminar)
Semnătura titularului de seminar
Lect. Dr. Isabela Drămnesc

Signature (director of the department)