

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

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**

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)**

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
<b>Distribution of the allocated amount of time / Distribuția fondului de timp*</b>					<b>hours/ore</b>
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

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)

4.1. curriculum / de curriculum	Not the case/Nu e cazul
4.2. skills / de competențe	Mathematics basis and the ability to solve problems / Cunostinte elementare de matematica si abilitati de rezolvarea a problemelor

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

5.1. for the lecture / de desfășurare a cursului	Room with whiteboard and videoprojector/ Sala de curs cu tabla si videoprojector
5.2. for the seminar, laboratory / de desfășurare a seminarului/laboratorului	Laboratory with computers with Mathematica installed (including the package Combinatorica) / Sala de laborator cu calculatoare cu Mathematica instalata (incluzand pachetul Combinatorica)

#### 6. Acquired skills / Competențe specifice acumulate

Professional skills / Competențe profesionale	<ul style="list-style-type: none"> <li>• 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 notiunile si principiile de baza din combinatorica: principii de numarare; permutari si combinari; algoritmi de generare si enumerare; structuri ciclice de permutari; teoria lui Polya; partitii, compozitii si algoritmi de generare; partitii de multimi.</li> <li>• Combinatorial reasoning based on counting techniques / Rationament combinatorial bazat pe tehnici de numarare.</li> <li>• Become familiar with the basic notions form the graph theory: definitions, classifications; data structures for graphs and related operations; graph generations; eulerian and hamiltonian trails and circuits; matchings; graph colorings; flow networks; planar graphs</li> </ul>
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	<p>/ 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.</p>
Transversal skills / Competențe transversale	<ul style="list-style-type: none"> <li>• 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.</li> </ul>

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

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"> <li>• <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.</li> <li>• <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.</li> <li>• <i>Attitude objective/Ob. Atitudinale (OAt):</i> Experiments with the educational and research tool Combinatorica, working with graphs, partitions, permutations, and other combinatorial objects / Experimamente cu instrumentul educational si de cercetare Combinatorica, pentru lucrul cu grafuri, partitii, permutari si alte obiecte combinatoriale.</li> </ul>

### 8. Content / Conținuturi\*

8.1. Lecture / Curs	Teaching strategies / Metode de predare	Remarks, details / Observații
1) Intoduction. 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 – <a href="http://web.info.uvt.ro/~idramnesc">http://web.info.uvt.ro/~idramnesc</a>  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 – <a href="http://web.info.uvt.ro/~idramnesc">http://web.info.uvt.ro/~idramnesc</a>  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 – <a href="http://web.info.uvt.ro/~idramnesc">http://web.info.uvt.ro/~idramnesc</a>  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 – <a href="http://web.info.uvt.ro/~idramnesc">http://web.info.uvt.ro/~idramnesc</a>  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, conversatie, exemplificare	References/Referinte :  1. Isabela Drămnesc – lecture slides – <a href="http://web.info.uvt.ro/~idramnesc">http://web.info.uvt.ro/~idramnesc</a>  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 ( <i>OC, Oab, OAt</i> )	Lecture, conversation, illustration / Prelegere, conversatie, exemplificare	References/Referinte :  1. Isabela Drămnesc – lecture slides – <a href="http://web.info.uvt.ro/~idramnesc">http://web.info.uvt.ro/~idramnesc</a>  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. Introduction to Graph Theory. ( <i>OC</i> )	Lecture, conversation, illustration / Prelegere, conversatie, exemplificare	References/Referinte :  1. Isabela Drămnesc – lecture slides – <a href="http://web.info.uvt.ro/~idramnesc">http://web.info.uvt.ro/~idramnesc</a>  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
8) Distance in Graphs. Trees ( <i>OC, Oab, OAt</i> )	Lecture, conversation, illustration / Prelegere, conversatie, exemplificare	References/Referinte :  1. Isabela Drămnesc – lecture slides – <a href="http://web.info.uvt.ro/~idramnesc">http://web.info.uvt.ro/~idramnesc</a>  2. J.M. Harris, J.L. Hirst, M.J. Mossinghoff. Combinatorics and Graph Theory. Second Edition.

		<p>Springer. 2008</p> <p>3. S. Pemmaraju, S. Skiena. Combinatorics and Graph Theory with Combinatorica. Cambridge University Press 2003</p>
<p>9) Kinds of graphs. Data structures for graph representation. Connectivity. The naive algorithm and Warshall algorithm. Bipartite graphs (<i>OC, Oab, OAt</i>)</p>	<p>Lecture, conversation, illustration / Prelegere, conversatie, exemplificare</p>	<p>References/Referinte :</p> <ol style="list-style-type: none"> <li>1. Isabela Drămnesc – lecture slides – <a href="http://web.info.uvt.ro/~idramnesc">http://web.info.uvt.ro/~idramnesc</a></li> <li>2. J.M. Harris, J.L. Hirst, M.J. Mossinghoff. Combinatorics and Graph Theory. Second Edition. Springer. 2008</li> <li>3. S. Pemmaraju, S. Skiena. Combinatorics and Graph Theory with Combinatorica. Cambridge University Press 2003</li> </ol>
<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"> <li>1. Isabela Drămnesc – lecture slides – <a href="http://web.info.uvt.ro/~idramnesc">http://web.info.uvt.ro/~idramnesc</a></li> <li>2. J.M. Harris, J.L. Hirst, M.J. Mossinghoff. Combinatorics and Graph Theory. Second Edition. Springer. 2008</li> <li>3. S. Pemmaraju, S. Skiena. Combinatorics and Graph Theory with Combinatorica. Cambridge University Press 2003</li> </ol>
<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"> <li>1. Isabela Drămnesc – lecture slides – <a href="http://web.info.uvt.ro/~idramnesc">http://web.info.uvt.ro/~idramnesc</a></li> <li>2. J.M. Harris, J.L. Hirst, M.J. Mossinghoff. Combinatorics and Graph Theory. Second Edition. Springer. 2008</li> <li>3. S. Pemmaraju, S. Skiena. Combinatorics and Graph Theory with Combinatorica. Cambridge University</li> </ol>

		Press 2003
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> )	Lecture, conversation, illustration / Prelegere, conversatie, exemplificare	References/Referinte :  1. Isabela Drămnesc – lecture slides – <a href="http://web.info.uvt.ro/~idramnesc">http://web.info.uvt.ro/~idramnesc</a>  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
13) Planar graphs. Graph colorings. Chromatic polynomials ( <i>OC, Oab, OAt</i> )	Lecture, conversation, illustration / Prelegere, conversatie, exemplificare	References/Referinte :  1. Isabela Drămnesc – lecture slides – <a href="http://web.info.uvt.ro/~idramnesc">http://web.info.uvt.ro/~idramnesc</a>  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
14) Revision ( <i>Oab, OAt</i> )	Lecture, conversation, illustration / Prelegere, conversatie, exemplificare	References/Referinte :  1. Isabela Drămnesc – lecture slides – <a href="http://web.info.uvt.ro/~idramnesc">http://web.info.uvt.ro/~idramnesc</a>  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
<b>Recommended bibliography / Bibliografie</b>		

[1] Isabela Drămnesc – lecture slides – <http://web.info.uvt.ro/~idramnesc>

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

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

[4] 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 / Problematizare, dialog, învățare prin colaborare	The students can access directly online the requests for the exercises ( <a href="http://web.info.uvt.ro/~idramnesc">http://web.info.uvt.ro/~idramnesc</a> ). 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 ( <a href="http://web.info.uvt.ro/~idramnesc">http://web.info.uvt.ro/~idramnesc</a> ). 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 Combinatorica package)	Questioning, dialogue, collaborative learning / Problematizare, dialog, învățare prin colaborare	Idem
3) Exercises related to lecture five and six. The use of Mathematica (Combinatorica package)	Questioning, dialogue, collaborative learning / Problematizare, dialog, învățare prin colaborare	Idem
4) Exercises related to lecture seven and eight	Questioning, dialogue, collaborative learning / Problematizare, dialog, învățare prin colaborare	Idem
5) Exercises related to lecture nine and ten	Questioning, dialogue, collaborative learning / Problematizare, dialog, învățare prin colaborare	Idem
6) Exercises related to lecture eleven and twelve	Questioning, dialogue, collaborative learning / Problematizare, dialog, învățare prin colaborare	Idem
7) Revision	Questioning, dialogue, collaborative learning / Problematizare, dialog,	Idem



învățare prin colaborare
<b>Recommended bibliography / Bibliografie</b>  [1] Isabela Drămnesc <a href="http://web.info.uvt.ro/~idramnesc">http://web.info.uvt.ro/~idramnesc</a>  [2] S. Pemmaraju, S. Skiena. Combinatorics and Graph Theory with Combinatorica. Cambridge University Press 2003  [3] <a href="http://www3.cs.stonybrook.edu/~skiena/combinatorica">http://www3.cs.stonybrook.edu/~skiena/combinatorica</a>  [4] 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)	Written exam during the semester / Test scris pe parcursul semestrului	25%
	2) The application of the concepts and algorithms in concrete cases / Aplicatii ale conceptelor si algoritmilor prezentați in cazuri concrete. (OAb)		
	1) Learning the concepts presented in the second part of the lectures: Graph Theory / Insusirea conceptelor prezentate in a doua	Written exam during the examination period / Test scris in sesiunea de examene	50%

	<p>parte a cursului: Teoria Grafurilor. (OC)</p> <p>2) The application of the concepts and algorithms in concrete cases /Aplicatii ale conceptelor si algoritmiilor prezentați in cazuri concrete. (OAb)</p>		
10.5. Seminar/ lab	Exercises related to the lectures / Exerciții referitoare la conținutul cursurilor predate (OAb, OAt)	Homework + activity during the semester (oral assessment)/ Teme + activitate laborator (evaluare orală)	25%
10.6. Minimal knowledge for passing / Standard minim de performanță			
<p>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.</p> <p>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.</p> <p>/ 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.</p> <p>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.</p>			

Date/ Data completării  
1.10.2016

Signature (lecture) /  
Semnătura titularului de curs

Signature (seminar)  
Semnătura titularului de seminar

Signature (director of the department)  
Semnătura directorului de departament  
Conf.dr. Victoria Iordan