SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	**Babeş Bolyai University**
1.2 Faculty	**Faculty of Mathematics and Computer Science**
1.3 Department	**Department of Computer Science**
1.4 Field of study	**Computer Science**
1.5 Study cycle	**Master**
1.6 Study programme / Qualification	**Component-Based Programming**

2. Information regarding the discipline

2.1 Name of the discipline	**Scientific Data Visualization**						
2.2 Course coordinator	**Lecturer Professor PhD. Prejmerean Vasile**						
2.3 Seminar coordinator	**Lecturer Professor PhD. Prejmerean Vasile**						
2.4. Year of study	**1**	2.5 Semester	**2**	2.6. Type of evaluation	**E**	2.7 Type of discipline	**Optional**

3. Total estimated time (hours/semester of didactic activities)

3.1 Hours per week	**4**	Of which: 3.2 course	**2**	3.3 seminar/laboratory	**1sem+ 1pr.**
3.4 Total hours in the curriculum	**56**	Of which: 3.5 course	**28**	3.6 seminar/laboratory	**28**
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					**28**
Additional documentation (in libraries, on electronic platforms, field documentation)					**28**
Preparation for seminars/labs, homework, papers, portfolios and essays					**28**
Tutorship					**14**
Evaluations					**21**
Other activities:					

3.7 Total individual study hours	**119**
3.8 Total hours per semester	**175**
3.9 Number of ECTS credits	**7**

4. Prerequisites (if necessary)

4.1. curriculum	• Ability to work with an integrated development environment
4.2. competencies	• Average programming skills in a visual programming language

5. Conditions (if necessary)

5.1. for the course	• An LCD projector
5.2. for the seminar /lab activities	• Laboratory with twelve computers; high level programming language environment

6. Specific competencies acquired

Professional competencies	• Ability to apply knowledge of computing and mathematics appropriate to the discipline; • Ability to analyze a problem, and identify and define the computing requirements appropriate to its solution; • Ability to identify and to specify computing requirements of an application and to design, implement, evaluate, and justify computational solutions; • Ability to use current techniques and skills to integrate available theory and tools necessary for applied computing practices.
Transversal competencies	• Ability to apply mathematical foundations, algorithmic principles, and computer science theory; • Ability to apply design and development principles in the construction of software systems; • Ability to acquire knowledge properly in an application domain in the modeling and design; • Ability to work effectively in a team.

7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	• Be able to apply theories, principles and concepts with technologies to design, develop, and verify computational solutions; • Be able to use data visualization (technique tool used to help researchers understand and/or interpret data)
7.2 Specific objective of the discipline	• To assimilate data visualization techniques and the visualization as a method of studying the real phenomenon. To gain skils related to problem solving through visualization of data. • To teach the students the concepts used in the field of modeling and visualization of simulation and to acquire the methods for validation of simulation using *Scientific Data Visualization*. • After promotion the students should be able to use data visualization as a method of solving real problems.

8. Content

8.1 Course	Teaching methods	Remarks
1. Scientific Data - data-formats used in science or engineering referred as scientific data; - scientific data as massive and digital data with a variety of data formats - floating-point data, integer data, image data, and clip data; - format and data dimensions (1-D, 2-D, 3-D, …)	Expositions: description, explanation, class lectures, Use of problems: use of problem questions, problems and problem situations. Other methods: company examples.	
2. Data Visualization - technique tool used to help researchers understand or interpret data; - similar techniques used in other visualization; - data analysis methods and techniques.	Expositions: description, explanation, dialog-based lectures, current lectures, Use of problems: problems and problem situations.	
3. Visualization Techniques - plotting (data analysis), mapping (graphics) - color image interpreting (image processing) - volume rendering (volume visualization) - graphics (Glut, OpenGL, …), animation - virtual reality (CaveLib, openGL, …) - internet, database and data management	Expositions: description, explanation, class lectures, dialog-based lectures, current lectures. Other methods: case study; company examples, discussion of material.	

4. Data Visualization Tools - Data Visualization Software; - Basic TecPlot guide.	Expositions: description, explanation, class lectures.	
5. Current issues in scientific visualization - scientific visualization models; - validation visualization; - design for scientific visualization.	Expositions: description, explanation, class lectures, dialog-based lectures, lectures.	
6. Data modeling - data representation; - modeling volumes; - unevenly distributed data modeling; - modeling by triangulation.	Expositions: description, explanation, class lectures, dialog-based lectures, lectures. Use of problems: use of problem questions	
7. Visual interactive simulation - what is simulation, when to use simulation, types of modeling and simulation,advantages of simulation, the steps of a simulation study. - visualization techniques for validation.	Expositions: description, explanation, introductive lectures, Other methods: case study; company examples.	
8. Visual interactive modeling and problem solving - visual onteractive models - sensitivity analysis, calibration, input-output data analysis for simulations	Expositions: description, explanation, class lectures, Use of problems: use of problem questions.	
9. Techniques needed for data visualization - applications of visualization; - data analysis and visualization; - visualizing multidimensional data; - data visualization unevenly distributed.	Expositions: description, explanation, dialog-based lectures, current lectures, Use of problems: problems and problem situations.	
10. Creative visualization - constructing isosurfaces, direct volume rendering, streamlines, streaklines, and pathlines, table, matrix, charts (pie chart, bar chart, histogram, function graph, scatter plot, etc.), graphs (tree diagram, network diagram, flowchart, existential graph, etc.), maps. - parallel coordinates - a visualization technique aimed at multidimensional data, treemap - a visualization technique aimed at hierarchical data, Venn diagram, Timeline, Euler diagram, Chernoff face, Hyperbolic trees, brushing and linking, Cluster diagram or dendrogram, Ordinogram	Expositions: description, explanation, class lectures, dialog-based lectures, current lectures. Other methods: case study; company examples, discussion of material.	
11. Interactive simulation and visualization applications - *Automatic 3-D animation and visualization* - *Interactive 3-D Model Construction* - *Surgical Simulation* - *3D MRI Aquisition and Visualization* - *Virtual Morphological Modelling*	Expositions: description, explanation, class lectures, dialog-based lectures, current lectures. Use of problems: use of problem questions, problems and problem situations.	
12. Data visualization in Business Analytics (visual technologiies, and data visualization). - visual analysis, scorecards, dshboards, 3D virtual reality.	Expositions: description, explanation, class lectures. Use of problems: use of problem questions.	

Bibliography

1. Arsham H., Systems Simulation: The Shortest Path from Learning to Applications, http://www.ubmail.ubalt.edu/~harsham/simulation/sim.htm
2. Averill M. Law and W. David Kelton, Simulation Modeling and Analysis, McGraw Hill, Third Edition (2000).
3. Daniel Hennessey, Algorithms for the Visualization and Simulation of Mobile Ad Hoc and Cognitive Networks - A Thesis Submitted to the Faculty of Drexel University – by Daniel Hennessey in partial fulfillment of the requirements for the degree of Master of Science in Computer Science, June 2009, http://idea.library.drexel.edu/bitstream/1860/3028/1/Hennessey_Daniel.pdf
4. Dodescu Gh., Simularea sistemelor, Ed.Militara, Bucuresti, 1986.
5. Fernando P. Birra, Manuel J. Prsospero, SiPaViS -A Toolkit for Scientific Visualization and Simulation, Computer Science Department, New University of Lisbon, P-2825 Monte Caparica, Portugal, emails: fpb@di.fct.unl.pt, Journal for Geometry and Graphics, Volume 3 (1999), No. 1, 47{55, ps@di.fct.unl.pt, http://www.heldermann-verlag.de/jgg/jgg01_05/jgg0304.pdf
6. Helmut Doleisch and Helwig Hauser, Smooth Brushing for Focus+Context, Visualization of Simulation Data in 3D, VRVis Research Center in Vienna, Austria, mailto: Doleisch, Hauser@VRVis.at, http://www.VRVis.at/vis/http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.18.2536&rep=rep1&type=pdf
7. Miller A. and Allen P. , Santos V., and Valero-Cuevas F., From robotic hands to human hands: a visualization and simulation engine for grasping research, http://www.cs.columbia.edu/~allen/PAPERS/industrialrobot.pdf
8. Popescu, G. D., Radoiu, D., Elemente de procesare digitala a informatiei, Universitatea Babes-Bolyai, Cluj Napoca, Facultatea de Fizica, 146 pag., 2000
9. Rădoiu, D., Popescu, G. D., Vizualizarea stiintifica a datelor experimentale, Editura Universitatii Petru Maior, 168 pag., ISBN 973-8084-05-9, 2000
10. Rădoiu D., Scientific Visualization; Editura "Casa Cărţii de Ştiinţă", Cluj-Napoca, 150 pag., ISBN 973-686-645-9, 2004;
11. Rodt T., Schlesinger A., Schramm A., Diensthuber M., Rittierodt M., Krauss J.K., 3D visualization and simulation of frontoorbital advancement in metopic synostosis, http://www.slicer.org/publications/item/view/1513
12. Rosenblum, L., R. Earnshaw, J. Encarnação, H. Hagen, A. Kaufman, S. Klimenko, G. Nielson, F. Post, D. Thalmannn, Scientific Visualization, Advances and Challenges, IEEE Computer Society Press, Academic Press, 1994
13. Spence, R., Information Visualization, Addison Wesley, 2001
14. Stephen Few, Data Visualization Past, Present, and Future, January 10, 2007. http://www.perceptualedge.com/articles/Whitepapers/Data_Visualization.pdf
15. VADUVA I., Modele de simulare cu calculatorul, Ed. Tehnica, Bucuresti 1977.
16. Win Cho Aye, Malcolm Yoke Hean Low, Huang Shell Ying, Hsu Wen Jing, Liu Fan, Zeng Min, Visualization and Simulation Tool for Automated Stowage Plan Generation System, http://www.iaeng.org/publication/IMECS2010/IMECS2010_pp1013-1019.pdf

8.2 Seminar		Teaching methods	Remarks
1.	The first two seminars are dedicated to surveying information sources available on Internet and Intranet, and planning of the papers and projects.	**Expositions**: description, explanation, introductive lectures. **Conversations**: debate, dialog, introductive conversations. **Other methods**: individual study, exercise, homework study.	
2.			

3. 4. 5. 6. 7. 8. 9.	The next seven seminars (from three to nine) are dedicated to paper presentations.	**Conversations**: debate, dialog, conversations for knowledge consolidation, conversations to systematize and synthesize knowledge. **Use of problems**: use of problem questions, problems and problem situations. **Other methods**: case study; cooperation, individual study, homework study, company examples, discussion of material.	
10. 11. 12.	The project demos will be scheduled in the last three seminars.	**Conversations**: debate, dialog. **Discovery**: discovery by documenting. **Other methods**: discussion of material.	

Bibliography

1. Beatriz Sousa Santos, Introduction to Data and Information Visualization, Universidade de Aveiro Departamento de Electrónica, Telecomunicações e Informática, Universidade de Aveiro, 2010 http://www.ieeta.pt/~bss/MAPI/Introduction-to-Vis-5-10.pdf
2. Brodlie, K., L. Carpenter, R. Earnshaw, J. Gallop, R. Hubbold, A. Mumford, C. Osland, P. Quarendon, Scientific Visualization, Techniques and Applications, Springer Verlag, 1992
3. Card, S., J. Mackinlay, B. Schneiderman (ed.), Readings in Information Visualization- Using Vision to Think, Morgan Kaufmann, 1999
4. Globus, A., Raible, "Fourteen Ways to say Nothing with Scientific Visualization", Computer, July 1994, pp.86-88
5. Jack P.C. Kleijnen, Five-stage procedure for the evaluation of simulation models through statistical techniques, Proceedings of the 1996 Winter Simulation Conference, p.248-254.
6. Keller, P., M. Keller, "The process of Visualization", Visual Cues, IEEE Computer Society Press, 1993, pp. 38-42
7. Keller, P., M. Keller, Visual Cues, IEEE Computer Society Press, 1993
8. Kleijnen J.P.C., Sensitivity analysis and optimization, Proceed. of the 1995 Winter Simulation Conference, p.133-140, 19959.
9. Kleijnen J.P.C., Validation of models: statistical techniques and data availability, Proceed. of the 1999 Winter Simulation Conference, 1999.
10. Lichenbelt, B., R. Crane, S. Naqvi, Introduction to Volume Rendering, Prentice Hall, 1998
11. Sanderson D.P., R.Sharma, R.Rozin, and S.Treu, The Hierarchical Simulation Language HSL: A Versatile Tool for Process-Oriented Simulation, ACM Trans.on Modeling and Computer Simulation, Vol.1, no.2, 1991, pp.113-153.
12. Schroeder, W., K. Martin, B. Lorensen, The Visulization Toolkit- An Object Oriented Approach to 3D Graphics, 2nd ed., Prentice Hall, 1998
13. SCOR_2006_visualization, Data Visualization, http://www.scor-int.org/Project_Summit_2/SCOR_2006_visualization.pdf
14. Shermer, M., "The Feynman-Tufte Principle", Scientific American, April 2005, pp. 38
15. T.I. Oren, Concepts and Criteria to Asses Acceptability of Simulation Study: a frame of reference, Comm.ACM, vol.24(1981), no.4, 180-184.
16. Tufte, E. "Graphical Excellence", in: Visual Explanations: Images and Quantities, Evidence and Narrative, Graphics Press, 1997, pp. 13-21.

17. Tufte, E. “Graphical Integrity”, in: Visual Explanations: Images and Quantities, Evidence and Narrative, Graphics Press, 1997, pp. 53-77
18. Tufte, E. “The Decision to Launch the Space Shuttle Challenger”, in: Visual Explanations: Images and Quantities, Evidence and Narrative, Graphics Press, 1997, pp.39,53
19. Tufte, E., The Visual Display of Quantitative Information, Graphics Press, 1983
20. Ware, C. , Information Visualization: Perception to Design, Academic Press, 2000

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

- This course exists in the curriculum of many universities in the world;
- The results of course are considered by companies of software particularly useful and topical.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	- know the basic elements and concepts of the Scientific Data Visualization;	Written exam	50%
10.5 Seminar / Project	- complexity, importance and degree of timeliness of the synthesis made	Paper presentation	15%
	- apply the course concepts - problem solving	Project presentation	35%
10.6 Minimum performance standards			
➢ At least grade 5 at written exam, paper presentations and project realised.			

Date	Signature of course coordinator	Signature of seminar coordinator
April 21, 2018	**Lect. Dr. PREJMEREAN Vasile**	**Lect. Dr. PREJMEREAN Vasile**

Date of approval ..... Signature of the head of department .....