1.	Course title	High performance computing (HPC)		
2.	Course code			
3.	Study program	KNI, IKI		
4.	Unit offering the course	**FCSE**		
5.	Undergraduate/postgraduate/PhD	**Undergraduate**		
6.	Year/semester 3/semester/elective	7. ECTS: **6**		
8.	Teacher(s)	d-r Marjan Gushev, d-r Sonja Filiposka, d-r Boro Jakimovski, d-r Igor Mishkovski		
9.	Course prerequisites	Computer architecture		
10.	Goals (competences): After the completion of this course, the students will have the knowledge of the architectures with high performance. They will understand the systems that are used for high performance computing and they will have the knowledge for algorithm speedup by their analysis and transformation based on available hardware infrastructure especially on their processor and memory hierarchy.			
11.	Course content: Architectures for systems for high performance computing (HPC). Characteristics of compilers for HPC systems. Programming languages for HPC. Massive memory systems and clusters. Grid infrastructures. Parallelization techniques such as loop unrolling, pipelining. Performance analysis, techniques and algorithms. Optimization of cache memory and main memory, design of memory hierarchy. CPU and memory intensive algorithms. Grid applications .Microprocessors for high performance. Design and evaluation of modern parallel processors. Principles of parallelism. Instruction level parallelism. Models of parallel programming. Communication primitives, techniques of programming and compilation. Current programming languages for parallel programming, vector compilers, environments, libraries and tools. Fundamental concepts of parallel algorithms. Virtualization and cloud computing. Concepts of virtualization, components and infrastructures. Virtualization at infrastructure level. Hardware and software virtualization. CPU virtualization. Storage virtualization. SaaS, PaaS and IaaS. Recovery and business continuity. Management and migration on the cloud. Mobile cloud computing. Design and implementation of cloud based applications. Scalability of applications and the future of the cloud.			
12.	Teaching methods: Teaching, supported by slides, interactive lecturing, exercises, projects, guest lectures, using online collaboration/commnication environments.			
13.	Total available time	6 ECTS x 30 hours = 180 hours		
14.	Distribution of the available time	30+45+25+40+40 = 180		
15.	Teaching activities	15.1.	Lectures	30 hours
		15.2.	Training (labs, problem solving), seminar and team work	45 hours

16.	Other activities	16.1.	Project work	25 hours
		16.2.	Self study	40 hours
		16.3.	Home work	40 hours

17.	Grading		
	17.1.	Tests	80 points
	17.2.	Seminar work/project (written or oral presentation)	15 points
	17.3.	Active participation	5 points

18.	Grading criteria	to 49 points	5 (five) (F)
		from 50 to 59 points	6 (six) (E)
		from 60 to 69 points	7 (seven) (D)
		from 70 to 79 points	8 (eight) (C)
		from 80 to 89 points	9 (nine) (B)
		from 90 to 100 points	10 (ten) (A)
19.	Final exam prerequisites	15.1 and 15.2	
20.	Course language	Macedonian and English	
21.	Quality assurance methods	Mechanisms of internal evaluation and polls	

22.	Literature					
	22.1.	Compulsory				
		No.	Authors	Title	Publisher	Year
		1.	Georg Hager, Gerhard Wellein	Introduction to High Performance Computing for Scientists and Engineers (Chapman & Hall/CRC Computational Science)	CRC Press	2010
		2.	Kris Jamsa	Cloud Computing	Jones & Bartlett Learning; 1 edition	2012
		3.	Adam Vile, James Liddle	The Savvy GuideTo HPC, Grid, Data Grid, Virtualisation and Cloud Computing	TheSavvyGuideTo	2008
	22.2.	Mandatory				
		No.	Authors	Title	Publisher	Year

		1.	F. Berman, G. Fox, T. Hey, (Eds)	Grid Computing; Making the Global Infrastructure a Reality	John Wiley & Sons Ltd	2003
		2.	Venkata Josyula, Malcolm Orr, Greg Page	Cloud Computing: Automating the Virtualized Data Center (Networking Technology)	Cisco Press	2011
		3.	Ivana Menken, Gerard Blokdijk	Cloud Computing Virtualization Specialist Complete Certification Kit	Emereo Publishing	2009