COURSE OUTLINE

(1) GENERAL

SCHOOLS	NATURAL SCIENCES		
ACADEMIC UNIT/UNITS	MATHEMATICS		
TITLE OF MASTER'S DEGREE	COMPUTATIONAL AND STATISTICAL DATA ANALYTICS (MCDA)		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	MCDA111	**SEMESTER**	B
COURSE TITLE	APPLIED BAYESIAN STATISTICS AND SIMULATION		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	WEEKLY TEACHING HOURS	CREDITS
Lectures	3	7.5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background
PREREQUISITE COURSES:	MCDA101
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes
COURSE WEBSITE (URL)	https://eclass.upatras.gr/courses/MATH957/

(2) LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning*

and Appendix B

- *Guidelines for writing Learning Outcomes*

Upon completing the course, students are expected to be able to:

- approach under Bayesian perspective any problem which they had previously encountered with the use of classical statistics,
- select appropriate prior distributions,
- calculate posterior distributions,
- make Bayesian inference and draw useful conclusions for the studied data sets,
- simulate observations from the posterior distribution using Monte Carlo and Markov Chain Monte Carlo techniques with appropriate software.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*……*
Production of new research ideas	*Others…*

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Decision making.
- Autonomous work.
- Working in an interdisciplinary environment.
- Promoting free, creative and inductive thinking.

(3) SYLLABUS

Introduction to Bayesian Statistics. The basic concept of Bayesian Statistics and its main difference from classical Statistics. Advantages of Bayesian Statistics. The Bayes Theorem.

Prior distributions. Relative likelihood method, histogram method, fit distribution with a given functional form, conjugate prior distributions, non-informative prior distributions (vague, Jeffreys distributions), Bayes empirical analysis, hierarchical prior distributions.

Posterior distribution: Compute the posterior distribution using various prior distributions. Compute the posterior distribution on data sets extensively used in the bibliography

Bayesian Inference: Elements of Statistical Decision Theory and Bayesian Decision Theory: loss function, risk function, decision rules, Bayes risk, Bayes rule and Bayes decision. Bayes estimators (posterior mean and median), Credible sets, Hypothesis tests (Bayes Factor, Fit of prior distributions for simple hypotheses). Predictive distributions.

Simulation: Pseudo random number simulation, Inverse method, accept - reject method, Importance Sampling. Introduction to Markov Chain Theory, Introduction to Markov Chain Monte Carlo (MCMC) methods, Metropolis - Hastings algorithm, Gibbs Sampler, Hybrid Gibbs Sampler.

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Lectures (face to face)</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>Use of ICT
• teaching with electronic slides,
• reference to appropriate software for simulation (Fortran, Mathematica, R),
• supporting the learning process through the eClass platform.</td></tr>
<tr><td>TEACHING METHODS
The manner and methods of teaching are described in detail.
Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.

The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>39</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Study (no driven)</td><td>41</td></tr>
<tr><td>Conduct assignment</td><td>44.5</td></tr>
<tr><td>Preparation and presentation of the final assignment</td><td>60</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Final examination</td><td>3</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Total number of hours for the Course (25 hours of work-load per ECTS credit)</td><td>187.5</td></tr>
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<tr><td>STUDENT PERFORMANCE EVALUATION
Description of the evaluation procedure

Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other

Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</td><td>Assessment Language: Greek
Assessment Language for Erasmus students: English

Assessment methods:
• two intermediate assignments (40%)
• Presentation of a special topic jointly selected by student and professor (60%)

Minimum passing grade: 5
Maximum passing grade: 10</td></tr>
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(5) ATTACHED BIBLIOGRAPHY

- Berger, J.O. (1985). *Statistical Decision Theory and Bayesian Analysis*. 2nd ed. Springer.
- Chen M.H., Shao, Q.M. and Ibrahim, J.G. (2000). *Monte Carlo Methods in Bayesian Computation*. Springer.
- Gelman, A., Carlin, J.B., Stern, H.S. and Rubin, D.B. (1995). *Bayesian Data Analysis*. Chapman & Hall.
- Ghosh, J.K., Delampady, M. and Tapas, S. (2006). *An Introduction to Bayesian Analysis: Theory and Methods*. Springer.
- Gilks, W.R., Richardson, S. and Spiegelhalter, D.J. (1996). *Markov Chain Monte Carlo in Practice*. Chapman & Hall.
- Ntzoufras, I. (2009). *Bayesian Modeling Using WinBUGS*. Wiley.
- Robert, C.P. (2001). *The Bayesian Choice*. 2nd ed. Springer.