

## COURSE OUTLINE

### (1) GENERAL

|                                                  |                                                                                                                                                         |                              |                 |
|--------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------------|
| <b>SCHOOL</b>                                    | SCHOOL OF INFORMATION SCIENCES & TECHNOLOGY                                                                                                             |                              |                 |
| <b>ACADEMIC UNIT</b>                             | DEPARTMENT OF STATISTICS                                                                                                                                |                              |                 |
| <b>LEVEL OF STUDIES</b>                          | 1st Cycle (UNDERGRADUATE)                                                                                                                               |                              |                 |
| <b>COURSE CODE</b>                               | 6145                                                                                                                                                    | <b>SEMESTER</b>              | 4 <sup>th</sup> |
| <b>COURSE TITLE</b>                              | Time Series Analysis                                                                                                                                    |                              |                 |
| <b>INDEPENDENT TEACHING ACTIVITIES</b>           |                                                                                                                                                         | <b>WEEKLY TEACHING HOURS</b> | <b>CREDITS</b>  |
| Lectures                                         |                                                                                                                                                         | 4                            | 8               |
| Workshops                                        |                                                                                                                                                         | 2                            |                 |
| Labs                                             |                                                                                                                                                         |                              |                 |
|                                                  |                                                                                                                                                         |                              |                 |
| <b>COURSE TYPE</b>                               | Compulsory - Background                                                                                                                                 |                              |                 |
| <b>PREREQUISITE COURSES:</b>                     |                                                                                                                                                         |                              |                 |
| <b>LANGUAGE OF INSTRUCTION and EXAMINATIONS:</b> | GREEK                                                                                                                                                   |                              |                 |
| <b>IS THE COURSE OFFERED TO ERASMUS STUDENTS</b> |                                                                                                                                                         |                              |                 |
| <b>COURSE WEBSITE (URL)</b>                      | <a href="https://www.dept.aueb.gr/en/stat/content/time-series-analysis-8-ects">https://www.dept.aueb.gr/en/stat/content/time-series-analysis-8-ects</a> |                              |                 |

### (2) LEARNING OUTCOMES

| Learning outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>After the successful completion of the course, students should be able to:</p> <ul style="list-style-type: none"> <li>• Determine mathematical time series models</li> <li>• Estimate numerical parameters of time series models</li> <li>• Predict values of modeled time series</li> <li>• Test model fit based on residuals of observed and predicted values</li> </ul>                                                                                  |
| General Competences                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <ul style="list-style-type: none"> <li>• Searching, analyzing and synthesizing data and information, using the necessary technologies</li> <li>• Adapting to new situations</li> <li>• Decision-making</li> <li>• Autonomous work</li> <li>• Teamwork</li> <li>• Working in an international environment</li> <li>• Working in an interdisciplinary environment</li> <li>• Generating new research ideas</li> <li>• Project planning and management</li> </ul> |

### (3) SYLLABUS

Introduction with examples of time series data. Concepts of stationarity. Autocorrelation function of stationary time series. The additive model with deterministic components (trend, seasonality). Classical tests for randomness and normality of the stochastic component. Linear filters of stationary time series. Stationary series representation as linear filters of uncorrelated noise and Wold's theorem. Autoregressive moving average model (ARMA), conditions for the existence of causality - reversibility of stationary linear solutions. Calculating the auto-covariance function of causal stationary solutions in the general ARMA (p,q) model. Bartlett's theorem and asymptotic statistical inference for autocorrelations. Predicting the minimum mean squared error. Algorithms for calculating optimal linear predictions functions (Durbin-Levinson, innovations) and its applications in predicting causal stationary ARMA models solutions. Partial autocorrelation function and its estimation.

Fitting causal stationary ARMA models:

a) preliminary estimators for autoregressive AR(p) models (Yule-Walker, least squares), moving average MA(q) models (innovations algorithm), mixed ARMA(p,q) models, (generalized Yule-Walker method), innovations algorithm).

b) maximum likelihood estimation and asymptotic inference. Diagnostic tests and criteria for choosing ARMA models rank (AIC, BIC).

Introduction to ARIMA and SARIMA models for non-stationary time series with a unit root, Dickey - Fuller test.

#### (4) TEACHING and LEARNING METHODS - EVALUATION

|                                                                 |                                                                                                                |                          |
|-----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|--------------------------|
| <b>DELIVERY</b><br><i>Face-to-face, Distance learning, etc.</i> | Face-to-face                                                                                                   |                          |
| <b>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY</b>         | YES                                                                                                            |                          |
| <b>TEACHING METHODS</b>                                         | <b>Activity</b>                                                                                                | <b>Semester workload</b> |
|                                                                 | Lectures                                                                                                       | 40                       |
|                                                                 | Lab Assignment                                                                                                 | 20                       |
|                                                                 | Studying and Analyzing Bibliography                                                                            | 55                       |
|                                                                 | Tutorial                                                                                                       | 20                       |
|                                                                 | Assignment writing                                                                                             | 10                       |
|                                                                 | Self Study                                                                                                     | 55                       |
|                                                                 | <b>Course Total</b>                                                                                            | <b>200</b>               |
| <b>STUDENT PERFORMANCE EVALUATION</b>                           | Written examination at the end of the semester: 100%<br>Project: 10%<br><br>Information is available at eclass |                          |

#### (5) ATTACHED BIBLIOGRAPHY

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• Μπόρα-Σέντα Ε., Μωυσιάδης Χ.Θ., Εφαρμοσμένη Στατιστική, Εκδόσεις Ζήτη, 1990.</li><li>• Zivot, Eric.Wang, Jiahui, Modeling Financial Time Series with S-PLUS, Springer Science and Business Media Inc., 2006.</li><li>• Shumway, Robert H., Stoffer, David S., Time Series Analysis and its Applications, Springer Science and Business Media LLC, 2006.</li><li>• Gilgen, Hans, Univariate Time Series in Geosciences, Springer-Verlag Berlin Heidelberg, 2006.</li><li>• Kirchgassner, Gebhard, Wolters, Jurgen, Introduction to Modern time Series Analysis, Springer-Verlag Berlin Heidelberg, 2007.</li><li>• Δαμιανού Χαράλαμπος Χ., ΜΕΘΟΔΟΛΟΓΙΑ ΔΕΙΓΜΑΤΟΛΗΨΙΑΣ, Εκδόσεις “σοφία”, 2007.</li><li>• Brockwell, P.J. and R.A. Davis (2002, 2nd Edition): Introduction to Time Series and Forecasting, Springer Verlag.</li><li>• Brockwell, P.J. and R.A. Davis (1991, 2nd Edition): Time Series: Theory and Methods, Springer Verlag.</li><li>• Cryer, J.D. and K.S. Chan (2008): Time Series Analysis With Applications in R, Springer-Verlag.</li><li>• Δημέλη Σ. (2003, 3η Έκδοση): Σύγχρονες Μέθοδοι Ανάλυσης Χρονολογικών Σειρών, Εκδόσεις ΚΡΙΤΙΚΗ, Αθήνα.</li></ul> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|