



## Teaching Guide

| Teaching Guide           |                                                                                                                                                       |        |                              |           |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------------------------|-----------|
| Identifying Data         |                                                                                                                                                       |        |                              | 2019/20   |
| Subject (*)              | Mathematical modeling in finance                                                                                                                      |        | Code                         | 614855211 |
| Study programme          | Mestrado Universitario en Matemática Industrial (2013)                                                                                                |        |                              |           |
| Descriptors              |                                                                                                                                                       |        |                              |           |
| Cycle                    | Period                                                                                                                                                | Year   | Type                         | Credits   |
| Official Master's Degree | 2nd four-month period                                                                                                                                 | First  | Optional                     | 6         |
| Language                 | Spanish                                                                                                                                               |        |                              |           |
| Teaching method          | Face-to-face                                                                                                                                          |        |                              |           |
| Prerequisites            |                                                                                                                                                       |        |                              |           |
| Department               | Matemáticas                                                                                                                                           |        |                              |           |
| Coordinador              | Vazquez Cendon, Carlos                                                                                                                                | E-mail | carlos.vazquez.cendon@udc.es |           |
| Lecturers                | Calvo Garrido, María Del Carmen                                                                                                                       | E-mail | carmen.calvo.garrido@udc.es  |           |
|                          | Vazquez Cendon, Carlos                                                                                                                                |        | carlos.vazquez.cendon@udc.es |           |
| Web                      | m2i.es/docs/modulos/EModelizacion/MBasica/6.%20Modelos%20matematicos%20en%20finanzas.pdf                                                              |        |                              |           |
| General description      | Se pretende que el alumno conozca los modelos y métodos matemáticos más utilizados para la valoración de productos financieros derivados más usuales. |        |                              |           |

## Study programme competences

| Code | Study programme competences                                                                                                                                                                                                                                                        |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A1   | Alcanzar un conocimiento básico en un área de Ingeniería/Ciencias Aplicadas, como punto de partida para un adecuado modelado matemático, tanto en contextos bien establecidos como en entornos nuevos o poco conocidos dentro de contextos más amplios y multidisciplinares.       |
| A2   | Modelar ingredientes específicos y realizar las simplificaciones adecuadas en el modelo que faciliten su tratamiento numérico, manteniendo el grado de precisión, de acuerdo con requisitos previamente establecidos.                                                              |
| A3   | Determinar si un modelo de un proceso está bien planteado matemáticamente y bien formulado desde el punto de vista físico.                                                                                                                                                         |
| A4   | Ser capaz de seleccionar un conjunto de técnicas numéricas, lenguajes y herramientas informáticas, adecuadas para resolver un modelo matemático.                                                                                                                                   |
| A5   | Ser capaz de validar e interpretar los resultados obtenidos, comparando con visualizaciones, medidas experimentales y/o requisitos funcionales del correspondiente sistema físico/de ingeniería.                                                                                   |
| A6   | Ser capaz de extraer, empleando diferentes técnicas analíticas, información tanto cualitativa como cuantitativa de los modelos.                                                                                                                                                    |
| A7   | Saber modelar elementos y sistemas complejos o en campos poco establecidos, que conduzcan a problemas bien planteados/formulados.                                                                                                                                                  |
| A8   | Saber adaptar, modificar e implementar herramientas de software de simulación numérica.                                                                                                                                                                                            |
| B1   | Saber aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios, incluyendo la capacidad de integrarse en equipos multidisciplinares de I+D+i en el entorno empresarial.                  |
| B2   | Poseer conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación, sabiendo traducir necesidades industriales en términos de proyectos de I+D+i en el campo de la Matemática Industrial |
| B3   | Ser capaz de integrar conocimientos para enfrentarse a la formulación de juicios a partir de información que, aun siendo incompleta o limitada, incluya reflexiones sobre las responsabilidades sociales y éticas vinculadas a la aplicación de sus conocimientos.                 |
| B4   | Saber comunicar las conclusiones, junto con los conocimientos y razones últimas que las sustentan, a públicos especializados y no especializados de un modo claro y sin ambigüedades.                                                                                              |
| B5   | Poseer las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo, y poder emprender con éxito estudios de doctorado.                                                                                 |

## Learning outcomes

| Learning outcomes | Study programme competences |
|-------------------|-----------------------------|
|-------------------|-----------------------------|



|                                                                                                                                                                     |                                 |                                 |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|---------------------------------|--|
| Knowledge of the management of the most popular financial products, specially options and bonds                                                                     | AC1<br>AC2<br>AC5<br>AC6<br>AC7 | BJ1<br>BC3<br>BR1               |  |
| Knowledge and application of the usual techniques of stochastic calculus to solve the pricing problems                                                              | AC2<br>AC6<br>AC7               | BJ1<br>BR1                      |  |
| Knowledge of the dynamic hedging methodology to pose Black-Scholes mathematical models                                                                              | AC2<br>AC3<br>AC7               | BJ1<br>BC1<br>BR1               |  |
| For a given financial derivative, ability to pose the most suitable Black-Scholes pricing model                                                                     | AC1<br>AC2<br>AC4<br>AC7        | BC1<br>BC2<br>BC3<br>BR1        |  |
| Knowledge of the most suitable numerical methods to solve the Black-Scholes models for the different financial products, either with one or two stochastic factors. | AC4<br>AC5<br>AC8               | BC1<br>BC2<br>BC3<br>BR1        |  |
| Knowledge about models of financial risk and the associated computations                                                                                            | AC1<br>AC2<br>AC5<br>AC6<br>AC7 | BJ1<br>BC1<br>BC2<br>BC3<br>BR1 |  |

| Contents                                                                                             |           |
|------------------------------------------------------------------------------------------------------|-----------|
| Topic                                                                                                | Sub-topic |
| 1. Financial markets and financial derivatives                                                       |           |
| 2. Discounted value of riskless financial products                                                   |           |
| 3. Pricing models for risky assets                                                                   |           |
| 4. Dynamic hedging methodologies and Black Scholes models                                            |           |
| 5. Black-Scholes models for options and bonds with one stochastic factor                             |           |
| 6. Black-Scholes models for options and bonds with two stochastic factors                            |           |
| Calculo de riscos financeiros: risco de valoración e de contraparte: Definicións, metodoloxía e uso. |           |

| Planning                       |                                              |                      |                               |             |
|--------------------------------|----------------------------------------------|----------------------|-------------------------------|-------------|
| Methodologies / tests          | Competencies                                 | Ordinary class hours | Student's personal work hours | Total hours |
| Problem solving                | A2 A3 A4 A5 A6 A7<br>B5 B3 B1                | 0                    | 60                            | 60          |
| Problem solving                | A2 A3 A4 A5 A6 A7<br>B5 B3 B1                | 0                    | 36                            | 36          |
| Objective test                 | A2 A3 A6 A7 B5                               | 4                    | 0                             | 4           |
| Guest lecture / keynote speech | A1 A2 A3 A4 A5 A6<br>A7 A8 B2 B5 B3 B1<br>B4 | 42                   | 0                             | 42          |
| Personalized attention         |                                              | 8                    | 0                             | 8           |



(\*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

| Methodologies                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Methodologies                  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Problem solving                | A set of problems is delivered to the student, some of them shorter to understand and practice concepts and technique, others are more complex.                                                                                                                                                                                                                                                                                                                                                               |
| Problem solving                | <ul style="list-style-type: none"> <li>- In the .pdf documents exhibited during lectures there are some easy exercises to review and apply the explained concepts</li> <li>- Moreover, some bibliographic references are indicated that contain exercises related to the developed subject</li> </ul>                                                                                                                                                                                                         |
| Objective test                 | Several problems are posed to be solved by the student who can use the slides containing the explanations in the lectures                                                                                                                                                                                                                                                                                                                                                                                     |
| Guest lecture / keynote speech | <ul style="list-style-type: none"> <li>- Previously to lecture sessions, a .pdf document with the slides to use in the lecture is delivered to students</li> <li>- Table PC and videoconference facilities will be used so that lectures can be followed by the students from the different campus</li> <li>- Participation of students with questions and comments will be encouraged. Questions will be solved and comments will be illustrated by means of Windows Journal computer application</li> </ul> |

| Personalized attention |                                                                                          |
|------------------------|------------------------------------------------------------------------------------------|
| Methodologies          | Description                                                                              |
| Problem solving        | Those problems solved by each student making part of the qualifications will be assessed |

| Assessment      |                            |                                                                                                                                                                              |               |
|-----------------|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Methodologies   | Competencies               | Description                                                                                                                                                                  | Qualification |
| Objective test  | A2 A3 A6 A7 B5             | A written exam of practical applications of the lectured contents will take place in a fixed date. In case of failing, a recovery exam will take place in a later fixed date | 60            |
| Problem solving | A2 A3 A4 A5 A6 A7 B5 B3 B1 | A set of exercises proposed to be solved outside classroom timetable will be evaluated                                                                                       | 40            |

| Assessment comments |
|---------------------|
|                     |

| Sources of information |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Basic                  | <ul style="list-style-type: none"> <li>- D. Brigo, M. Morini, A. Pallavicini (2013). Counterparty credit risk, collateral and funding. Wiley Financial Series</li> <li>- J. Gregory (2010). Counterparty credit risk: the new challenge for global financial markets. Wiley Financial Series</li> <li>- J.C.Hull (2000). Options, Futures and Other Derivatives. Prentice-Hall Inc., (New Jersey)</li> <li>- T.Mikosch (1998). Elementary Stochastic Calculus with Finance in View. World Scientific, (Singapur)</li> <li>- A. Pascucci (2011). PDE and martingale methods in option pricing. Bocconi University Press, Springer</li> <li>- R.Seydel (2007). Tools for Computational Finance. Universitext, Springer-Verlag</li> <li>- C. Vázquez (2010). An introduction to Black-Scholes modeling and numerical methods in derivatives pricing. MAT Serie A</li> <li>- P.Wilmott, S.Howison, J.Dewynne (1996). The mathematics of Financial Derivatives, A Student Introduction. Cambridge University Press</li> <li>- P.Wilmott, S.Howison, J.Dewynne (1996). Option Pricing: Mathematical Models and Computation. Oxford Financial Press</li> <li>- P.G.Zhang (1998). Exotic Options, A guide to second generation option. World Scientific (Singapur)</li> </ul> |
| Complementary          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

| Recommendations |
|-----------------|
|                 |



|                                                          |
|----------------------------------------------------------|
| Subjects that it is recommended to have taken before     |
| Stochastic numerical methods/614855226                   |
| Subjects that are recommended to be taken simultaneously |
|                                                          |
| Subjects that continue the syllabus                      |
| Professional software in finance/614855218               |
| Other comments                                           |
|                                                          |

(\*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.