



Financial Technology and digital innovation to modernise and develop curricula of Vietnamese and Philippines Universities

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MASTER IN FINTECH AND DIGITAL INNOVATION - MODULE SYLLABUS -



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Table of Contents

1. Module details	4
2. Module description	4
3. Learning Outcomes.....	4
4. Module knowledge, skills and competencies (EQF*)	5
5. Module lessons	5

1. Module details

Module Title	Analytics and Programming in Finance
Credits	/
Hours	
N° of hours in presence	
N° of hours in distance learning	<i>At least 15</i>
Name of the leading institution	

2. Module description

This course develops the use of analytical techniques and the basic programming elements required for applying computational methods in finance. The course covers basic and advanced statistical and optimization approaches to data analytics and their application in various areas in FinTech with software packages Python and R. The key topics cover: descriptive analytics including basic probability and statistics, categorical data, time series data, regressions models, predictive analytics techniques and prescriptive analytics including linear programming, integer programming, dynamic programming, stochastic programming, game theory. The emphasis is on the application to practical problems, such as: asset pricing, derivatives, proprietary trading, portfolio management and other problems related to financial service industry.

3. Learning Outcomes

The course overall learning outcomes are:

Knowledge and Understanding:

- a. Demonstrates a critical understanding of technology-based banking concepts (e.g. digital banking, open banking, etc.);
- b. Demonstrates understanding and awareness of emerging technological enablers in banking and finance (e.g. digitalisation, automation, machine learning, AI, etc.);
- c. Demonstrates a critical awareness of current, emerging and future issues for FinTech.

Application and Problem-Solving Abilities:

- a. Applies a significant range of specialist database and software operating, programming and other FinTech relevant skills;

4. Module knowledge, skills and competencies (EQF*)

Moreover, at the end of this course, the student will be able to ([*https://europa.eu/europass/en/european-qualifications-framework-efq](https://europa.eu/europass/en/european-qualifications-framework-efq)) :

- Collect, manage, and analyze data from different sources;
- Analyze and model specialized and complex problems in finance;
- Critically compare, contrast and evaluate the different analytics techniques for applicability to identified problems;
- Establish use of analytic techniques for finance applications;
- Apply numerical analysis and programming in Python and R to solve financial problems;
- Analyze, reports, demonstrate and implement obtained solutions.

5. Module lessons

Lesson N.	1
Lesson title	Fundamentals of Analytics
Duration	1h
Specific objectives	Provide students the core concepts of analytics and the role of data analytics in finance
Topics	<ul style="list-style-type: none"> • Developing Analytical Thinking • Descriptive Analytics • Predictive Analytics • Prescriptive Analytics • Data Driven Finance • Analytics in Finance.
In presence activity	<ul style="list-style-type: none"> • Lectures • lecture discussion
Distance learning type of learning object /task	<ul style="list-style-type: none"> • Virtual classroom/ web-streaming conference • Lecture note

	<ul style="list-style-type: none"> • Audio/Video Lesson
Other supporting material	

Lesson N.	2
Lesson title	Collecting, Sorting, Prioritizing, and Storing Big Data
Duration	1h
Specific objectives	Provide students the understanding of data and the knowledge about data capturing and manipulation
Topics	<ul style="list-style-type: none"> • Finding and Capturing the Right Data • Data Sampling and Preparation • Data Segmentation • Data Warehousing • Data Security • Fitting Analytics Models to Data
In presence activity	<ul style="list-style-type: none"> • Lectures • lecture discussion
Distance learning type of learning object /task	<ul style="list-style-type: none"> • Virtual classroom/ web-streaming conference • Lecture note • Audio/Video Lesson
Other supporting material	Min, H. (2016). <i>Global business analytics models: Concepts and applications in predictive, healthcare, supply chain, and finance analytics</i> . FT Press. (Chapter 2)

Lesson N.	3
Lesson title	Introduction to R Language for Statistical Computing
Duration	1h

Specific objectives	Provide students core concepts of R
Topics	<ul style="list-style-type: none"> • Language Features: Functions, Assignment, Arguments, Types, Binding, and Arrays • Error Handling • Numeric, Statistical, and Character Functions • Data Frames and Input–Output • Lists
In presence activity	<ul style="list-style-type: none"> • Lectures • lecture discussion • programming demonstration • programming exercises
Distance learning type of learning object /task	<ul style="list-style-type: none"> • Virtual classroom/ web-streaming conference • Lecture note • Audio/Video Lesson
Other supporting material	Bennett, M. J., & Hugen, D. L. (2016). <i>Financial analytics with R: building a laptop laboratory for data science</i> . Cambridge University Press. (Chapter 2)

Lesson N.	4
Lesson title	Descriptive Analytics (1) - Basic Statistical Tools
Duration	1h
Specific objectives	Provide students the knowledge about basic statistical elements, methods and techniques.
Topics	<ul style="list-style-type: none"> • Probability, Combinatorics, Mathematical Expectation, Sample Mean, Standard Deviation, and Variance, Sample Skewness and Kurtosis, Sample Covariance and Correlation • Statistical Distributions • Examples Applying Statistics to Financial Data

In presence activity	<ul style="list-style-type: none"> • Lectures • lecture discussion • exercise
Distance learning type of learning object /task	<ul style="list-style-type: none"> • Virtual classroom/ web-streaming conference • Lecture note • Audio/Video Lesson
Other supporting material	Tsay, R. S. (2014). <i>An introduction to analysis of financial data with R</i> . John Wiley & Sons. (Chapter 1)

Lesson N.	5
Lesson title	Descriptive Analytics (2) - Financial Statistics in R
Duration	1h
Specific objectives	Provides the students the knowledge about features of R for financial statistics and skills to use them in real problems.
Topics	<ul style="list-style-type: none"> • Calculating Financial Returns in R • Solving Capital Asset Pricing Model in R
In presence activity	<ul style="list-style-type: none"> • Lectures • lecture discussion • programming demonstration • programming exercises
Distance learning type of learning object /task	<ul style="list-style-type: none"> • Virtual classroom/ web-streaming conference • Lecture note • Audio/Video Lesson • Self-evaluation test
Other supporting material	Bennett, M. J., & Hugen, D. L. (2016). <i>Financial analytics with R: building a laptop laboratory for data science</i> . Cambridge University Press. (Chapter 2)

Lesson N.	6
Lesson title	Predictive Analytics (1) - Linear Models for Financial Time Series
Duration	1h
Specific objectives	Provide students the knowledge about analysis of time series..
Topics	<ul style="list-style-type: none"> • Stationarity • Correlation and Autocorrelation Function • Linear Time Series • Simple Autoregressive Models
In presence activity	<ul style="list-style-type: none"> • Lectures • lecture discussion • exercise
Distance learning type of learning object /task	<ul style="list-style-type: none"> • Virtual classroom/ web-streaming conference • Lecture note • Audio/Video Lesson
Other supporting material	Tsay, R. S. (2014). <i>An introduction to analysis of financial data with R</i> . John Wiley & Sons. (Chapter 1)

Lesson N.	7
Lesson title	Predictive Analytics (2) - Financial Time Series Analysis in R
Duration	1h
Specific objectives	Provide students the knowledge about financial time series and skills to use R for their analysis as well the visualization of financial time series.
Topics	<ul style="list-style-type: none"> • Examining Financial Time Series • Visualization of Financial Data
In presence activity	<ul style="list-style-type: none"> • Lectures • lecture discussion • programming demonstration • programming exercises

Distance learning type of learning object /task	<ul style="list-style-type: none"> • Virtual classroom/ web-streaming conference • Lecture note • Audio/Video Lesson
Other supporting material	Bennett, M. J., & Hugen, D. L. (2016). <i>Financial analytics with R: building a laptop laboratory for data science</i> . Cambridge University Press. (Chapter 2)

Lesson N.	8
Lesson title	Predictive Analytics (3) - Simple Forecasting in R
Duration	1h
Specific objectives	Provide students the knowledge about forecasting, simple forecasting models and skills to forecast using R.
Topics	<ul style="list-style-type: none"> • Moving Average Models • Exponential Smoothing • Seasonal Models
In presence activity	<ul style="list-style-type: none"> • Lectures • lecture discussion • programming demonstration • programming exercises
Distance learning type of learning object /task	<ul style="list-style-type: none"> • Virtual classroom/ web-streaming conference • Lecture note • Audio/Video Lesson • Assignments
Other supporting material	<p>Tsay, R. S. (2014). <i>An introduction to analysis of financial data with R</i>. John Wiley & Sons. (Chapter 1)</p> <p>Ruppert, D., & Matteson, D. S. (2011). <i>Statistics and data analysis for financial engineering</i>. Springer. (Chapters 12, 13)</p>

Lesson N.	9
Lesson title	Predictive Analytics (4) - Advanced Forecasting in R
Duration	1h
Specific objectives	Provide students the knowledge about advanced forecasting models and skills to forecast using R..
Topics	<ul style="list-style-type: none"> • Regression Models with Time Series Errors • Long-Memory Models
In presence activity	<ul style="list-style-type: none"> • Lectures • lecture discussion • programming demonstration • programming exercises
Distance learning type of learning object /task	<ul style="list-style-type: none"> • Virtual classroom/ web-streaming conference • Lecture note • Audio/Video Lesson • Self-evaluation test
Other supporting material	<p>Tsay, R. S. (2014). <i>An introduction to analysis of financial data with R</i>. John Wiley & Sons. (Chapter 1)</p> <p>Ruppert, D., & Matteson, D. S. (2011). <i>Statistics and data analysis for financial engineering</i>. Springer. (Chapters 12, 13)</p>

Lesson N.	10
Lesson title	Prescriptive Analytics (1) - Modelling
Duration	1h
Specific objectives	Provide students the knowledge optimization problems in finance and skills to build the mathematical models.
Topics	<ul style="list-style-type: none"> • Decision-making Problems in Finance • Mathematical Model Building • Examples of optimization problems in

	Finance
In presence activity	<ul style="list-style-type: none"> • Lectures • lecture discussion • exercises
Distance learning type of learning object /task	<ul style="list-style-type: none"> • Virtual classroom/ web-streaming conference • Lecture note • Audio/Video Lesson
Other supporting material	Cornuejols, G., Peña, J. & Tütüncü, R. (2018). <i>Optimization methods in finance</i> . Cambridge University Press (Chapter 1)

Lesson N.	11
Lesson title	Prescriptive Analytics (2) - Model Solving
Duration	1h
Specific objectives	Provide students the understanding of mathematical models types and solving corresponding methods.
Topics	<ul style="list-style-type: none"> • Linear Programming (LP) • Nonlinear Programming (NP) • Integer and Mixed Integer Programming (IP, MIP) • Dynamic Programming • Optimization with Data Uncertainty
In presence activity	<ul style="list-style-type: none"> • Lectures • lecture discussion
Distance learning type of learning object /task	<ul style="list-style-type: none"> • Virtual classroom/ web-streaming conference • Lecture note • Audio/Video Lesson
Other supporting material	Cornuejols, G., Peña, J. & Tütüncü, R. (2018). <i>Optimization methods in finance</i> . Cambridge University Press (Chapter 1)

Lesson N.	12
Lesson title	Introduction to Python Language
Duration	1h
Specific objectives	Provide the students the core concepts and model of Value at Risk.
Topics	<ul style="list-style-type: none"> • The Python Programming Language Syntax • Software libraries and their usage in Python • Using optimization libraries
In presence activity	<ul style="list-style-type: none"> • Lectures • lecture discussion • programming demonstration • programming exercises • Problems solving • Case Study Exercises
Distance learning type of learning object /task	<ul style="list-style-type: none"> • Virtual classroom/ web-streaming conference • Lecture note • Individual report • Audio/Video Lesson • Video example • Case Study • Self-evaluation test • Group assignments • Group presentation
Other supporting material	Hilpisch, Y. (2019). <i>Python for finance: mastering data-driven finance</i> . O'Reilly Media

Lesson N.	13
Lesson title	Prescriptive Analytics (3) - Solving LP Models in Python
Duration	1h

Specific objectives	Provide students the knowledge about linear programming models in finance and skills to solve real LP problems using Python.
Topics	<ul style="list-style-type: none"> • Optimal Short Term Financing (STF) Problem Modeling • Solving STF problem in Python
In presence activity	<ul style="list-style-type: none"> • Lectures • lecture discussion • programming demonstration • programming exercises
Distance learning type of learning object /task	<ul style="list-style-type: none"> • Virtual classroom/ web-streaming conference • Lecture note • Audio/Video Lesson • Self-evaluation test
Other supporting material	<p>Cornuejols, G., Peña, J. & Tütüncü, R. (2018). <i>Optimization methods in finance</i>. Cambridge University Press (Chapter 3)</p> <p>Hilpisch, Y. (2019). <i>Python for finance: mastering data-driven finance</i>. O'Reilly Media</p> <p>Hart, W. E., Laird, C. D., Watson, J. P., Woodruff, D. L., Hackebeil, G. A., Nicholson, B. L., & Sirola, J. D. (2017). <i>Pyomo-optimization modeling in python</i> (Vol. 67). Berlin: Springer.</p>

Lesson N.	14
Lesson title	Prescriptive Analytics (4) - Solving NP Models in Python
Duration	1h
Specific objectives	Provide students the knowledge about nonlinear programming models in finance and skills to solve real NP problems using Python.
Topics	<ul style="list-style-type: none"> • Portfolio Optimization Problem Modeling • Solving Portfolio Optimization Problem in Python

In presence activity	<ul style="list-style-type: none"> • Lectures • lecture discussion • programming demonstration • programming exercises
Distance learning type of learning object /task	<ul style="list-style-type: none"> • Virtual classroom/ web-streaming conference • Lecture note • Audio/Video Lesson
Other supporting material	<p>Cornuejols, G., Peña, J. & Tütüncü, R. (2018). <i>Optimization methods in finance</i>. Cambridge University Press (Chapter 8)</p> <p>Hart, W. E., Laird, C. D., Watson, J. P., Woodruff, D. L., Hackebeil, G. A., Nicholson, B. L., & Sirola, J. D. (2017). <i>Pyomo-optimization modeling in python</i> (Vol. 67). Berlin: Springer.</p>

Lesson N.	15
Lesson title	Prescriptive Analytics (5) - Solving IP Models in Python
Duration	1h
Specific objectives	Provide students the knowledge about integer and mixed-integer programming models in finance and skills to solve real NP problems using Python.
Topics	<ul style="list-style-type: none"> • Constructing an Index Fund (CIF) Problem Modeling • Solving CIF in Python
In presence activity	<ul style="list-style-type: none"> • Lectures • lecture discussion • programming demonstration • programming exercises
Distance learning type of learning object /task	<ul style="list-style-type: none"> • Virtual classroom/ web-streaming conference • Lecture note • Case Study



Other supporting material

Cornuejols, G., Peña, J. & Tütüncü, R. (2018). *Optimization methods in finance*. Cambridge University Press (Chapter 12))

Hart, W. E., Laird, C. D., Watson, J. P., Woodruff, D. L., Hackebeil, G. A., Nicholson, B. L., & Sirola, J. D. (2017). *Pyomo-optimization modeling in python* (Vol. 67). Berlin: Springer.

Add tables for additional lessons if necessary