ASIA PACIFIC COLLEGE
3 Humabon Place, Magallanes Makati City

SCHOOL of COMPUTING AND INFORMATION TECHNOLOGIES
Modeling and Simulation Course Syllabus

APC Vision

Asia Pacific College envisions itself to be the preferred Higher Education Institution bridging academe and industry with its programs founded on the concepts and applications of IT, guided by the core values of integrity, industry and innovation that works.

APC Mission

Asia Pacific College, powered by education and industry professionals as faculty and a balanced curriculum, aims to provide business and the information and communications technology industry in the Philippines and in the global community lifelong learning graduates who are anchored on the principles of integrity and professionalism.

APC Values

APC aims to produce graduates with strong sense of **industry** or hard work, **integrity** or being honest and having strong moral / ethical principles, and **innovation** or constantly introducing new and creative methods or ideas.

APC Graduate Attributes

Solution Provider	Applies knowledge, concepts, theories, and industry-based skills in order to identify, solve, and recommend solutions aligned to the goals of its users and the organization to which they operate Develops ideas and solutions with creativity and innovation, and with appropriate considerations to ethical, cultural, and environmental factors
Committed	Fulfills commitments, made to one's self and the organization, beyond expectations Copes with the demands of goals, commitments, and responsibilities even when faced with unexpected situations
IT Enabled	Uses innovative methods and appropriate technologies to perform tasks effectively and efficiently
Professional	Understands the needs of customers and audiences, as well as the intent and spirit of their requirements, in order to respond appropriately in verbal and nonverbal forms
Team Player	Functions effectively as an individual and as a member of diverse teams in multidisciplinary settings by respecting and recognizing individual and cultural differences and strengths Encourages, motivates, and inspires others to perform, cooperate, and achieve team goals
Good Communicator	Communicates effectively and ethically using the English language
Ethical Professional	Understands social and ethical responsibilities

Contributor to Nation Building	Recognizes the needs of society, and contributes ideas to address societal concerns and issues for the betterment of the nation and its citizens
Lifelong Learner	Recognizes the fast-paced demands of the industry, allowing one to formulate personal goals aligned to organizational goals in order to determine plans of action to improve one's performance and capability; possesses the ability to engage in independent and life-long learning in the broadest context of technological change; determines one's developmental needs through self-assessment

Bachelor of Science in Computer Science Program Educational Objectives

	Program Educational Objectives	Alignment with APC Mission, Vision and Values
PEO1	To be able to apply, articulate and discuss computing concepts and theories, algorithmic foundations and new developments and trends in computing in any field in Computer Science	Innovation
PEO2	To be able to provide a significant contribution using computer science concepts, applications, tools and methodologies to enable innovations in organizational processes and human activities	Innovation
PEO3	To be able to design and develop IT solutions integrating the perspectives of professionalism, public policy, legal and ethical dimensions of IT, with the core values of APC, balancing the needs of its users and that of society, in general	Integrity and Ethics
PEO4	To be able to adapt with societal, business, and technological changes by continuously and actively engaging in: a. career and professional activities b. continuing education	Industry and Lifelong Learning
PEO5	To effectively communicate orally and in writing	Industry, Integrity, and Communication
PEO6	To work effectively and independently in multidisciplinary and multi-cultural teams	Industry and Teamwork

Computer Science Graduate Outcomes

CS01	Apply knowledge of computing fundamentals, knowledge of a computing specialization, and mathematics, science, and domain knowledge appropriate for the computing specialization to the abstraction and conceptualization of computing models from defined problems and requirements.
CS02	Identify, analyze, formulate, research literature, and solve complex computing problems and requirements reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant domain disciplines
CS03	An ability to apply mathematical foundations, algorithmic principles and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices
CS04	Knowledge and understanding of information security issues in relation to the design, development and use of information systems
CS05	Design and evaluate ideas and solutions with creativity and innovation for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, ethical and environmental considerations.

CS06	Create, select, adapt, and apply appropriate techniques, resources and modern computing tools to complex computing activities, with an understanding of the limitations to accomplish a common goal. Uses innovative methods and appropriate technologies to perform tasks effectively and efficiently
CS07	Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings by respecting and recognizing individual and cultural differences and strengths. Encourages, motivates, and inspires others to perform, cooperate and achieve team goals.
CS08	Communicate effectively and ethically, with emphasis on the English language, with the computing community and with society at large about complex computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations, and give and understand clear instructions
CS09	The ability to recognize the legal, social, ethical, and professional issues involved in the utilization of computer technology and be guided by the adoption of appropriate professional, ethical and legal practices
CS10	Recognize the need, and have the ability, to engage in independent life-long learning in the broadest context of technological change for continual development as a computing professional. It also recognizes the fast-paced demands of industry allowing one to formulate personal goals aligned to organizational goals in order to determine plans of action to improve one's performance and capability; determines one's developmental needs through self-assessment.
CS11	Recognizes the needs of society and contributes ideas to address societal concerns and issues for the betterment of the nation and its citizens.
CS12	Understands the needs of customers and audience and the intent and spirit of their requirements in order to respond appropriately in verbal and non-verbal forms.
CS13	Fulfills commitments, made to self and the organization, beyond expectations. Copes with the demands of goals, commitments, and responsibilities even when faced with unexpected situations

Course Code	:	**MODESIM**

Course Name	:	**MODELING AND SIMULATION**

Course Description	:	This course covers the basic principles of modeling and simulation using a general-purpose programming language. Topics in this course include, but are not limited to, systems definition, stochastic and deterministic models, simulation techniques, and model verification and validation techniques.

Course Credit	:	**Three (3) units**

Course Prerequisite	:	**QUAMET1**

COURSE OUTCOMES

At the end of the course, students will be able to:

Course Outcomes (CO)	Graduate Outcomes Aligned to
C1: Quantitatively model and simulate systems using relevant tools.	CS01 CS03
C2: Implement simple models, by either replicating or extending established models, and then validate and verify the correctness of these models.	CS03 CS05 CS06
C3: Formulate scientific research questions correctly, and confidently and clearly communicate scientific results, either through a written or oral report.	CS02 CS03 CS08 CS09

Learning Output

As evidence to measure the achievement of the course outcomes, the following will be required from the learners towards the end of the course:

- A research project that implements a model of a system, runs simulations, and analyzes data.

COURSE OUTLINE

Week	Topics	Learning Activities	Learning Outcomes	Instructional Materials	Deliverables/ Outcomes	Assessment
1	• Course Outline and Class Policies • Overview of the tools, learning platforms, and coding environments to be used in class • Project Overview • Python Basics • Introduction to Modeling and Simulation • The Modeling Process	• Discussion • Tools demo • Coding exercise • LinkedIn Learning course completion	• Describe the course outline and class policies. • Explain the course outcomes and relate the learning output. • Recall the features of the available learning platforms and coding environments • Review basic programming structures using Python. • Define and explain the terms model, simulation, and system. • Perform the modeling process using Python	• Class orientation slides • APC Handbook • LinkedIn Learning course for Python review: Hands-On Introduction: Python • Introduction to Modeling and Simulation slides • Bikeshare example from [2] to illustrate modeling process	• LinkedIn Learning Certificate • Bikeshare python code	• Quiz • Coding exercise
2	• Linear Regression • Categorical Independent Variables	• Code demo • Computer simulation	• Determine the best-fit linear model to a given data set • Interpret the coefficients of a linear regression model • Derive and interpret the coefficient of determination and the correlation coefficient in the context of a given data set.	• Linear Models slides • Code samples	• Linear regression model coding assignment	• Coding exercise

3	• Logistic Regression
	• Project Overview
	• Project Work
		• Discussion
		• LinkedIn Learning video viewing on the content for the sections in Project Deliverable 1
		• LinkedIn Learning course completion
			• Create a logistic regression model given a data set
			• Apply available Python libraries in developing a logistic regression model and calculating appropriate performance metrics
			• Interpret the coefficients of a logistic regression model
			• Create a problem statement for the chosen topic
			• Write appropriate research questions
			• Create the hypothesized solutions to the research questions
				• Logistic Regression slides
				• LinkedIn Learning course: Machine Learning with Python: Logistic Regression
				• Final project templates
				• LinkedIn Learning videos on research:
				  ○ Independent and dependent variables (3 min, 25 sec)
				  ○ Elements of a research question (3 min, 26 sec)
				  ○ How to write a research question (2 min, 39 sec)
					• Logistic regression model coding assignment
					• Project Deliverable 1
						• Quiz
						• Coding exercise
						• Project Deliverable 1

Week	Topics	Learning Activities	Learning Outcomes	Instructional Materials	Deliverables/ Outcomes	Assessment
				o Create research objectives (3 min, 13 sec) o Research frameworks and hypotheses (3 min, 22 sec)		
4-6	• Other nonlinear regression models • Project Deliverable 2 • Data Preprocessing • Data Analysis from Questionnaires	• LinkedIn Learning course completion • LinkedIn Learning video viewing on data preprocessing	• Choose an appropriate method in creating a best fit model given a data set. • Decide on how to handle categorical data and missing data. • Explain each group's project method for analysis.	• LinkedIn Learning videos on nonlinear regression models: o Defining natural logs and exponents o Performing exponential regression analysis o Performing logarithmic regression analysis o Performing a power regression analysis o Performing polynomial regression analysis o Performing logistic regression • LinkedIn Learning course: Python Data Analysis (2 hours, 30 minutes) • LinkedIn Learning videos on data preprocessing (all come from the course Python: Working with Predictive Analytics (1 hour, 17 min)): o Differentiate data types (4 min, 50 sec) o Python libraries and data import (4 min, 34 sec)	• Preprocessed project data set • Project Deliverable 2	• Coding exercise • Quiz

Week	Topics	Learning Activities	Learning Outcomes	Instructional Materials	Deliverables/ Outcomes	Assessment
				o Handling missing values (4 min, 45 sec) o Convert categorical data into numbers (6 min, 38 sec) o Feature scaling (6 min, 58 sec)		
7	• Estimating Models from Empirical Data • Forecasting • Stochastic Models • Monte Carlo Simulation • Optimization using Goal Seek	• Discussion • Code demo • LinkedIn Learning course completion	• Explore input data for analysis • Apply basic forecasting models (naïve, moving average, trendline) • Compare different types of forecasting models. • Compute a variety of error measures. • Simulate a stochastic process using the Monte Carlo method • Perform optimization using goal seek.	• Lecture slides • Data sets for demo • LinkedIn Learning course Excel: Analytics Tips (2 hours, 1 min)	LinkedIn Learning Certificate	• In-video quizzes • Problem solving exercise
8	• Introduction to Machine Learning • Python for Data Science • Verification, Validation, Errors	• Microsoft Learn module completion • LinkedIn Learning course completion	• Describe machine learning and differentiate from traditional algorithms • Create and test machine learning models • Load a model and apply it to new sets of data • Differentiate verification from validation • Apply verification and validation guidelines to deterministic and stochastic models	• Microsoft Learn module Introduction to Machine Learning • LinkedIn Learning course Python for Data Science Essential Training Part 2	LinkedIn Learning Certificate Microsoft Learn badge and certificate	• In-video quizzes • Coding exercise
10	• Model Evaluation • Project work: Discussion on Project Deliverable 3 + Consultation • Case Study: Agent-Based Modeling – Virus Spread	• Discussion • Excel / Code demo • Project consultation	• Compute and interpret error measures • Evaluate models • Define and identify the components of agent-based models • Apply ABM to virus spread	• Lecture slides • Data sets for demo • LinkedIn Learning course Applied Machine Learning: Foundations	LinkedIn Learning certificate	• In-video quizzes • Problem solving exercise
11	• Case Study: Epidemiology – SIR	• Discussion	• Define and explain the SIR Model	• Lecture slides	Simulation code	• Coding exercises

Week	Topics	Learning Activities	Learning Outcomes	Instructional Materials	Deliverables/ Outcomes	Assessment
	Model • Project work: Discussion on Project Deliverable 4 + Consultation	• Code demo	• Apply the SIR model to virus spread • Simulate virus spread when interventions are executed	• Data sets for demo		and results interpretation
12	• Case Study: Queues • Project work: Project Deliverable 4 completion	• Lecture • Demo • Computer Simulation	• Describe queueing theory • Simulate queues at check-out counters • Complete the pre-final draft copy of the final project	• Lecture slides • Data sets for demo	Paper pre-final draft	Pre-final draft
13	• Final paper peer review	Lecture, demo, computer simulation	• Give objective feedback on another group's project.	• Pre-final draft • Peer reviewer form	Filled-out Peer Reviewer form	Peer review
14	• Project Completion: Integration to final paper of peer reviews	• Group work • Consultation	• Integrate peer feedback into the final project. • Complete the final project.	• Final paper template • Final project rubrics	Final paper Presentation slides Presentation Recording	Final project

TEXTBOOK

[1] Kinser, J. M. (2022). *Modeling and Simulation in Python*. Taylor & Francis.

REFERENCES

[2] Downey, A. (2017). *Modeling and Simulation in Python*. Needham, MA: Green Tea Press. Retrieved from http://greenteapress.com/modsimpy/ModSimPy3.pdf.

[3] Gordon, S. & Guilfoos, B. (2017). *Introduction to modeling and simulation with Matlab and Python*. Boca Raton, FL: CRC Press Taylor & Francis Group, LLC.

[4] McKinney, W. (2018). *Python for Data Analysis*. Sebastopol, California : O'Reilly Media, Inc.

[5] Nagar, S. (2018). *Introduction to Python for Engineers and Scientists : Open-Source Solutions for Numerical Computation*. Berkeley, CA : Apress.

[6] Sundnes, J. (2020). *Introduction to Scientific Programming with Python*. Springer International Publishing.

[7] Tagliaferri, L. et al. (2019). *Python Machine Learning Projects*. DigitalOcean.

[8] Velten, K. (2009). *Mathematical modeling and simulation: introduction for scientists and engineers*. Wiley-VCH.

[9] Williams, E. (2019). *Python for Data Science*.

INSTRUCTIONAL MATERIALS

a. Sustainable Development Goals (learning output motivation)
b. Books
c. Video clips
d. Online courses from LinkedIn Learning
e. Possible data sources:
    a. Kaggle Datasets
    b. Google Dataset Search
    c. Open Data Philippines
    d. World Bank Open Data

GRADING SYSTEM

Project Deliverables / Problem Sets	40%
Project Proposal / Final Project	30%
Assignments / Lab Exercises	25%
Class Participation	5%
Total	**100%**

Final Course Grade: 50% (1st half grade) + 50% (2nd half grade)

*1st half grade (i.e. midterm grade) is computed from scores obtained in week 1 up to week 7.
*2nd half grade is computed from scores obtained in week 8 up to week 14.

Learning Output RUBRICS

Research Paper

Aspects of Paper	5	4	3	2	1
Title Section	Title, and members' information complete	1 to 2 errors in the title section	3 to 4 errors in the title section	4 or more errors in the title section	No title nor members' names indicated
Abstract	Can be understood by those with minimal knowledge of the discipline; uses an introduction/body/ conclusion structure which logically follows the chronology of the work; is concise without being choppy	Uses an introduction/body/ conclusion structure which logically follows the chronology of the work; is concise without being choppy	Uses an introduction/body/ conclusion structure which logically follows the chronology of the work; however, some parts are choppy	States the abstract in a single sentence	Incomplete and/or unfocused
Body	Each paragraph has thoughtful supporting detail sentences that develop the main idea.	Each paragraph has enough supporting detail sentences that develop the main idea.	Some paragraphs have enough supporting details that develop the main idea	Each paragraph lacks the supporting detail sentences.	Each paragraph fails to develop the main idea.
Figures, tables, and equations	All figures, tables, and equations are clearly and logically identified and strongly support the text.	Most figures, tables, and equations are clearly and logically identified and support the text.	Only a few of the figures, tables, and equations are clearly and logically identified and somehow support the text.	Most of the figures, tables, and equations are identified but does not support the text.	None of the figures, tables, and equations are clearly and logically identified and does not support the text.
Organization	Writer demonstrates logical and subtle sequencing of ideas through well-developed paragraphs; transitions are used to enhance organization.	Paragraph development present but not perfected.	Logical organization; some ideas are fully developed	Logical organization; organization of ideas not fully developed.	No evidence of structure or organization.
Mechanics	No errors in punctuation, capitalization, and spelling.	Almost no errors in punctuation, capitalization and spelling.	Few errors in punctuation, capitalization, and spelling	Many errors in punctuation, capitalization and spelling.	Numerous and distracting errors in punctuation, capitalization and spelling.
Citation	All cited works are done in the correct format with no errors.	Some cited works are done in the correct format with no errors	Few cited works are done in the correct format with no errors.	Citation exists but in an incorrect format	No citation at all

Presentation Rubric

Aspects of Presentation	4	3	2	1
Organization	Well thought out with logical progression; significance clearly stated; use of proper language; content level appropriate for audience; strong opening and closing	Talk easy to follow; content was presented in mostly logical sequence; significance clearly stated; content level not always appropriate; use proper language; fairly strong opening and closing	Talk somewhat disorganized; content was presented in inadequate sequence; shows somewhat effort to use proper language; significance somewhat unclear; includes irrelevant content and inappropriate content level; weak opening and closing	Talk difficult to follow; little thought given to sequence of content; repetitive; transitions choppy; does not understand significance of work; unclear language; lacked opening and closing
Creativity and Visual Aids	Tables and graphs summarize data and/or conclusions; size and label are clear; very little text; figures and images explained and described well; presentation has no misspellings or grammatical errors	Text appropriately sized; very little text; most figures and images explained and described well; presentation as occasional misspelling or grammatical error	Labels and legends somewhat unclear; text size somewhat small; too much detail on slides; blocks of text on slides; figures are explained; presentation has multiple misspellings and/or grammatical errors	Labeling is not clear; size is too small to see; no logical placement of information; mostly text and very few images; figures are not explained; presentation has numerous misspellings and/or grammatical errors
Understanding of Scientific Content	Identifies the research question / research field; has advanced understanding of the experimental approach and significance; critically evaluates results, methodology, and conclusions; scientifically rigorous and well researched	Identifies the research question / research field; understands the experimental approach and significance; limited evaluation of results, methodology, and conclusions; well researched	Research question / research field somewhat unclear; description of experimental approach somewhat confusing; results and conclusions stated but not critically evaluated; does not integrate outside readings	Does not understand the research; does not understand the experimental approach; does not understand conclusions or recognize implications for future work
Style / Delivery	Uses time wisely; poised, clear articulation; proper volume; steady rate of speaking; good eye contact; does not read information; enthusiastic; confident; uses engaging tone and appropriate vocabulary	Clear articulation but not polished; volume and rate of speaking fluctuated; some eye contact; speaks well, but often repeats comments; some enthusiasm and confidence; uses good vocabulary and tone	Presentation poorly timed; some mumbling; some hesitation and uncertainty are apparent; volume uneven; little eye contact or enthusiasm; looks at notes; monotone and non-engaging delivery	Presentation poorly timed; Speaking inaudible or too loudly; very little eye contact; rate too slow; speaker seemed uninterested; speaks to quietly or quickly for audience to hear and understand
Ability to Answer Questions	Anticipates audience questions; understands audience	Does not anticipate audience questions; understands audience	Does not anticipate audience questions, makes an effort to	Either makes no effort to respond to

Aspects of Presentation	4	3	2	1
	questions; can integrate knowledge to answer questions; thoroughly responds to questions	questions; can integrate knowledge to answer questions; thoroughly responds to most questions	address question; can address some questions; often responds poorly to questions	questions or does so poorly

CLASSROOM POLICIES

1. All APC policies on attendance and plagiarism/cheating, among others, are enforced.
2. Students are expected to attend all scheduled synchronous classes. It is the responsibility of the student to catch up for all lectures missed due to his/her absence.
3. All assignments/deliverables must be submitted on or before their respective deadlines. Ensure that you press the **Turn In** button when submitting the final version of an assignment.
4. If, for some reason, you fail to submit deliverables on time, please send a notification to your instructor. Adjustments may be made on a case-to-case basis.
5. The instructor reserves the right to modify this syllabus as the pace of the class dictates.

CONSULTATION HOURS

You may send your queries about the subject to your instructor through email or via Microsoft Teams. For long discussions, set a meeting through Microsoft Teams. For questions that require short and quick answers, you may send them via Microsoft Teams chat.

Prepared by:	Gardon, R.W.	Reviewed by:		Approved by:	
Date	December 2022	Date			