هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

2023
TP-153

Course Specification
(Bachelor)

Course Title:	Biomathematics
Course Code:	2024113-3
Program:	Bachelor in Mathematics
Department:	Mathematics and Statistics Department
College:	Faculty of Sciences
Institution:	Taif University
Version:	1
Last Revision Date:	14/10/2023

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A. General information about the course:

1. Course Identification

1. Credit hours: 3(3,1,0)					
2. Course type					
A.	☐University	☐College	☒ Department	☐ Track	☐Others
B.	☐ Required		☒ Elective		
3. Level/year at which this course is offered: Level 7 / Fourth Year					
4. Course general Description:					
In this course, students dive into essential biomathematical concepts like Stability Analysis, Phase-Plane Behavior, Direction Field, and the Routh and Hurwitz Criterion. Bifurcation analyses, covering various types, shed light on complex dynamical systems. We explore single-species and two-species population dynamics, emphasizing stability and competition models. Equilibrium and stability in one and two dimensions are studied analytically and graphically. Addressing discrete populations, we delve into annual reproductive organisms using logistic and Nicholson Bailey models. Compartmental modeling, crucial in diverse fields, simplifies complex systems such as disease dynamics. The course extends to pharmacokinetics, tumor formulation, biological movement, and pattern formation, culminating in computer simulations. Students acquire vital skills to navigate biomathematical complexities.					
5. Pre-requirements for this course (if any)**:**					
Ordinary differential equations (2022201-4)					
6. Co-requirements for this course (if any)**:**					
None					
7. Course Main Objective(s):					
• Describing the biological scenario into a mathematical model. • Applying mathematics in solving some biological phenomena. • Develop practical modeling expertise for real-world applications in biomathematics.					

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	**3Hr /Week**	100%
2	E-learning		
3	Hybrid • Traditional classroom • E-learning		
4	Distance learning		

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	45
2.	**Laboratory/Studio**	NA
3.	**Field**	NA
4.	**Tutorial**	NA
5.	**Others (specify)**	NA
Total		**45**

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	Recognize development of the governing model equations.	K1	• Lectures • Group discussions	• Quizzes • Assignments
1.2	Outline the concepts of mathematical biology.	K2	• Lectures • Group discussions	• Exams • Assignments
2.0	**Skills**			
2.1	Apply the mathematical modelling biological and biomedical systems.	S3	• Interactive classes • Group discussions	• Quizzes • Assignments
2.2	Explain applications of mathematics and computational approaches	S4	• Lectures • Group discussions	• Exams • Assignments

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
	to questions involving biological phenomena,			
2.3	Use various electronic resources, analytical and mathematical techniques for data analysis and problem solving.	S4	• Lectures • Self-learning through the website	• Exams • Quizzes • Assignments
3.0	**Values, autonomy, and responsibility**			
3.1	Articulate ethical behavior associated with institutional Guidelines in classroom, and in Lab.	V3	• Lectures • Group discussions	• Exams • Quizzes

Course Content

No	List of Topics	Conta Hours
1.	In the initial segment of our course, students will delve deep into the fundamental concepts of biomathematical modeling. This foundational knowledge will cover crucial topics, including Stability Analysis and Phase-Plane Behavior. Through these lessons, students will establish a robust understanding of the core principles that underpin biomathematics.	3
2.	In addition to Direction Field, another pivotal focus will be on the Routh and Hurwitz Criterion. These fundamental concepts form the bedrock of understanding intricate biological systems. They equip students with the essential tools to dissect and analyze complex biomathematical models, providing a profound insight into the underlying mechanisms.	3
3.	Exploring bifurcation analyses, encompassing Transcritical Bifurcation, Saddle-Node Bifurcation, Pitchfork Bifurcation, Hopf Bifurcation, and Solution Types. This in-depth examination provides a comprehensive understanding of the various bifurcation phenomena, offering valuable insights into complex dynamical systems.	3
4.	Examples of continuous single-species populations provide valuable insights into the behaviour of basic populations using established dynamical systems tools, such as stability analysis. These models focus on enhancing our biological understanding and investigating the underlying assumptions. Key topics encompass the logistic growth model. Moreover, when considering the standard logistic model, we could consider the	3

	concept of constant-rate harvesting, and explore harvesting methods for maximum economic yield.	
5.	Extending the single-species model to encompass two species competing for a finite resource, which could be food, territory, nesting locations, or mechanisms to evade predation. The habitats of these two species intersect. Key topics encompass Predator-Prey models, and Lokta-Volterra competition.	3
6.	Examine the equilibrium and stability analysis of the mentioned dynamics in both one-dimensional and two-dimensional continuous time settings. Utilize graphical techniques to explore stability.	3
7.	Many organisms, especially in temperate regions, reproduce annually, leading to discrete population changes. To address this discrete behavior, we introduce a mapping function, denoted as f, which models the population transition from one year to the next, represented as xt+1 = f(xt). We will examine discrete-time variations of the logistic model as well as the Nicholson Bailey Model.	3
8.	First midterm	3
9.	The prevalent method in analyzing system dynamics across diverse fields such as biology, epidemiology, pharmacokinetics, physiology, and chemical reactions is compartmental modeling. This approach simplifies the system's structure while retaining essential characteristics of its underlying dynamic processes. Essentially, a compartmental model dissects the system into distinct interconnected states, elucidating system dynamics by focusing on the overall rate of change within each compartment. In this lecture, we explore compartmental modeling and illustrate its applications through examples drawn from various disciplines.	3
10.	Exploring Epidemiological Models for Infectious Diseases, we delve into the fundamental frameworks of disease dynamics, namely the SIS and SIR models. Our investigation places significant emphasis on uncovering the biological insights these models offer and dissecting the foundational assumptions that form their core. Additionally, we examine the diversities and complexities that emerge as these assumptions are eased, providing a comprehensive view of the subject.	3
11	Physiology and pharmacokinetics, compartmental modelling to understand the effect of drug treatment.	3
12.	Second Midterm exam	3
13.	Tumor formulation	3
14	Biological Movement and Pattern Formation	3
15	Development of the computer simulations of the model equations.	3
	Total=45	

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Quizzes	Continuous Evaluation	10 %
2.	Assignments, report	Continuous Evaluation	10 %
3.	Midterm 1 Exam	8-9	15%
4.	Midterm 2 Exam	12-13	15%
5.	Final Exam	15-16	50%

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	C. S. Chou, A. Friedman, "Introduction to mathematical biology. Modeling, analysis, and simulations", Springer Undergraduate Texts in Mathematics and Technology, ISBN 978-3-319-29636-4. (2016)
Supportive References	1-D. Barnes, D. Chu, "Introduction to Modelling for Biosciences" Springer Verlag. ISBN 1-84996-325-8. (2010). 2-F. Hoppensteadt, " Guide to Simulation and Modeling for Biosciences " Springer Verlag. ISBN 978-1-4471-6761-7. (2015). 3- G. de Vries, T. Hillen, M. Lewis, J.Muller, and B. Schoenfisch," A Course in Mathematical Biology: Quantitative Modelling with Mathematical and Computational Methods", Monographs on Mathematical Modelling and Computation. SIAM. (2008) 4-Ruth Baker, "Mathematical Modelling in Biology Lecture Notes" ,Oxford university. (2018) 5- Perko, Lawrence. *Differential equations and dynamical systems*. Vol. 7. Springer Science & Business Media, 2013.
Electronic Materials	**Mathematical Biology, https://www.youtube.com/watch?v=Lp3T4DtAyOo&t=1016s**
Other Learning Materials	**Matlab and Mathemaica tutorial** **https://www.youtube.com/watch?v=Lp3T4DtAyOo&t=1016s** https://www.youtube.com/watch?v=XcYt0A9uLh0&list=PLbMVogVj5nJSRAqzS5HV8xzqcRR_wyHec

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms,	Classrooms, Computer Labs

Items	Resources
simulation rooms, etc.)	
Technology equipment (Projector, smart board, software)	Data show, Blackboard
Other equipment (Depending on the nature of the specialty)	None

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students, Program Leader	Direct & Indirect
Effectiveness of students assessment	Faculty, Program Leader	Direct
Quality of learning resources	Students, Faculty	Indirect
The extent to which CLOs have been achieved	Faculty	Direct & Indirect
Other		

Assessors (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	Department Council
REFERENCE NO.	4
DATE	October 2023

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