Form: Course Syllabus	**Form Number**	EXC-01-02-02A
	Issue Number and Date	2/3/24/2022/2963 05/12/2022
	Number and Date of Revision or Modification	02/11/2024
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	The Date of the Deans Council Approval Decision	23/01/2023
	Number of Pages	07

1.	**Course Title**	**Nonlinear Optimization**
2.	**Course Number**	0301772
3.	**Credit Hours (Theory, Practical)**	3
	Contact Hours (Theory, Practical)	3
4.	**Prerequisites/ Corequisites**	None
5.	**Program Title**	M.Sc. in Mathematics
6.	**Program Code**	
7.	**School/ Center**	Science
8.	**Department**	Mathematics
9.	**Course Level**	Elective specialization requirement
10.	**Year of Study and Semester (s)**	1st and 2nd years, 1st and 2nd semesters
11.	**Other Department(s) Involved in Teaching the Course**	None
12.	**Main Learning Language**	English
13.	**Learning Types**	☑Face to face learning ☐Blended ☐Fully online
14.	**Online Platforms(s)**	☐Moodle ☑Microsoft Teams
15.	**Issuing Date**	16/11/2024
16.	**Revision Date**	16/11/2024

17. Course Coordinator:

Name: Prof. Baha Alzalg	Contact hours: TBA
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18. Other Instructors:

Name:	Contact hours:
Office number:	Phone number:
Email:	

19. Course Description:

Theory of unconstrained nonlinear optimization problems including conditions for local minimizers, algorithms for unconstrained nonlinear optimization including search methods for one-dimensional optimization, some search methods for multi-dimensional optimization, introduction to the theory of nonlinear constrained optimization.

20. Program Student Outcomes (SO's):

- **SO1.** Read, analyze and write logical arguments to prove mathematical and statistical concepts and theorems.
- **SO2.** Analyze and apply different mathematical algorithms and theories and use modern techniques in both teaching and research.
- **SO4.** Formulate mathematical and statistical problems by modeling real-life problems, and solve them theoretically and/or numerically using technological tools.
- **SO6.** Apply knowledge and mathematical tools and think creatively to solve real life problems and then verify and interpret the results correctly.
- **SO7.** Work effectively within work teams and communicate scientific knowledge and results with peers and experts in the field.
- **SO8.** Apply methodologies and ethics of scientific research in preparation of scientific research in mathematics field.

21. Course Intended Learning Outcomes (CLO's):

Upon completion of the course, the student will be able to achieve the following intended learning outcomes.

- **CLO1.** To apply appropriate theories, principles and concepts relevant to nonlinear optimization.
- **CLO2.** To formulate nonlinear programming models and apply the graphical method for solving two- and three-dimensional problems.
- **CLO3.** To learn about the theory of constrained and unconstrained optimization.
- **CLO4.** To study numerical algorithms for solving unconstrained optimization problems.
- **CLO5.** To be able to select a reasoned argument to the solution of familiar and unfamiliar problems relevant to nonlinear optimization.
- **CLO6.** To plan and design practical activities using techniques and procedures appropriate to nonlinear optimization.

Course CLOs	The learning levels to be achieved					
	Remembering	Understanding	Applying	Analysing	evaluating	Creating
CLO (1)	●	●				
CLO (2)		●	●			
CLO (3)	●	●		●		
CLO (4)		●	●	●	●	
CLO (5)		●	●		●	
CLO (6)		●	●		●	●

22. The matrix linking the intended learning outcomes of the course with the intended learning outcomes of the program:

Program SO's / Course CLO's	SO (1)	SO (2)	SO (3)	SO (4)	SO (5)	SO (6)	SO (7)	SO (8)
CLO (1)	●							
CLO (2)				●		●		
CLO (3)	●							
CLO (4)		●		●			●	●
CLO (5)	●							●
CLO (6)		●		●			●	●

23. Topic Outline and Schedule:

Week	Lecture	Topic	CLO/s Linked to the Topic	Learning Types Face to Face (FF) Blended (BL) Fully Online (FO)	Platform Used	Synchronous (S) Asynchronous (A)	Evaluation Methods	Learning Resources
1	1.1	Introduction and syllabus discussion	1	FF	Boards	S		Textbook
	1.2	General form for nonlinear programming (NLP) problems, definitions	1	FF	Boards	S		Textbook
2	2.1	NLP formulation and examples	2	FF	Boards	S		Textbook
	2.2	The graphical method for two-dimensional NLP	2	FF	Boards	S		Textbook
3	3.1	Mathematical background	1	FF	Boards	S		Textbook
	3.2	Fundamentals of constrained and unconstrained optimization	1, 3	FF	Boards	S		Textbook
4	4.1	First-order necessary conditions	1, 3	FF	Boards	S		Textbook
	4.2	Second-order necessary conditions	1, 3	FF	Boards	S		Textbook
5	5.1	Second-order sufficient conditions	1, 3, 5	FF	Boards	S		Textbook
	5.2	Line search methods for one-dimensional nonlinear optimization	4	FF	Boards	S		Textbook
6	6.1	Golden section search method	4	FF	Boards	S		Textbook
	6.2	Fibonacci method	4	FF	Boards	S		Textbook
7	7.1	Newton's method and secant method	4, 6	FF	Boards	S		Textbook
	7.2	Gradient methods for higher-dimensional nonlinear optimization: Steepest Ascent method	4, 6	FF	Boards	S		Textbook
8	8.1	**Midterm Exam**		FF		S		

	8.2	Newton's method for nonlinear optimization	4, 6	FF	Boards	S		Textbook
9	9.1	Newton's method for nonlinear systems	4, 6	FF	Boards	S		Textbook
	9.2	Conjugate direction methods for higher - dimensional nonlinear optimization	4, 6	FF	Boards	S		Textbook
10	10.1	Basic conjugate direction method	4, 6	FF	Boards	S		Textbook
	10.2	Conjugate gradient method	4, 6	FF	Boards	S		Textbook
11	11.1	Quasi-Newton methods for higher-dimensional nonlinear optimization	4, 6	FF	Boards	S		Textbook
	11.2	The single-rank symmetric algorithm	4, 6	FF	Boards	S		Textbook
12	12.1	The Davidon-Fletcher-Powell algorithm	4, 6	FF	Boards	S		Textbook
	12.2	The Broyden- Fletcher-Goldfarb-Shanno algorithm	4, 6	FF	Boards	S		Textbook
13	13.1	**Second exam**		FF	Boards	S		
	13.2	Problems with equality constraints	1, 3	FF	Boards	S		Textbook
14	14.1	Lagrange condition	1, 3	FF	Boards	S		Textbook
	14.2	Problems with inequality constraints	1, 3	FF	Boards	S		Textbook
15	15.1	Karush-Kuhn-Tucker condition	1, 3, 5	FF	Boards	S		Textbook
	15.2	Second-order conditions	1, 3, 5	FF	Boards	S		Textbook
16		**Final Exam**						

24. Evaluation Methods:

Opportunities to demonstrate achievement of the CLOs are provided through the following assessment methods and requirements:

Evaluation Activity	Mark	Topic(s)	CLO/s Linked to the Evaluation activity	Period (Week)	Platform
Midterm exam	% 30	TBA	1-4	TBA	On Campus
Second exam	% 30	TBA	3-6	TBA	On Campus
Final exam	% 40	All topics	1-6	TBA	On Campus

25. Course Requirements:

Each student must have:

- Account on Microsoft Teams.

26. Course Policies:

A. Attendance policies: Attendance is absolutely essential to succeed in this course. You are expected to attend every class; please notify your instructor if you know you are going to be absent. All exams must be taken at the scheduled time. Exceptions will be made only in extreme circumstances, by prior arrangement with the instructor.

B. Absences from exams and submitting assignments on time: If a student is absent for more than 10% of lectures without an excuse of sickness or due to other insurmountable difficulty, then he/she shall be barred from the final examination also he/she will get a failing grade in this course.

C. Health and safety procedures: Medical certificates shall be given to the University Physician to be authorized by him. They should be presented to the Dean of the Faculty within two weeks of the student's ceasing to attend classes.

D. Honesty policy regarding cheating, plagiarism, misbehavior: Cheating is prohibited. The University of Jordan regulations on cheating will be applied to any student who cheats in exams or on home works.

E. Grading policy: Test papers shall be returned to students after correction. His/her mark is considered final after a lapse of one week following their return.

F. Available university services that support achievement in the course: Math library, Computer lab.

27. References:

A- Required book(s), assigned reading and audio-visuals:

- Edwin K. Chong, Stanislaw H. Zak. *An Introduction to Optimization*. 4th Edn, Wiley, 2013.

B- Recommended books, materials, and media:

- David G. Luenberger. *Introduction to Linear and Nonlinear Programming*. 2nd Edn, Addison-Wesley, 1973.
- Andrzej P. Ruszczynski. *Nonlinear Optimization*. Princeton University Press, 2006.
- Jorge Nocedal, Stephen J. Wright. *Numerical Optimization*. 2nd Edn, Springer, 2006.

28. Additional information:

Name of the Instructor or the Course Coordinator: **Prof. Baha Alzalg**	Signature: ……	Date: 02/11/2024
Name of the Head of Quality Assurance Committee/ Department: **Prof. Manal Ghanem**	Signature: ……	Date: ……
Name of the Head of Department: **Prof. Baha Alzalg**.	Signature: ……	Date: ……
Name of the Head of Quality Assurance Committee/ School of Science: **Prof. Emad A. Abuosba**	Signature: ……	Date: ……
Name of the Dean or the Director: **Prof. Mahmoud I. Jaghoub**	Signature: ……	Date: ……