Course Specifications

Course Title:	**Multivariable Calculus**
Course Code:	**30112253-4**
Program:	**BSc. Mathematics 301100**
Department:	Mathematical Science
College:	Applied Sciences
Institution:	**Umm Al-Qura University**

Table of Contents

A. Course Identification

1. Credit hours:	**4 hours**
2. Course type	
a.	University ☐ College ☐ Department ☐ Others ☐
b.	Required ☐ Elective ☐
3. Level/year at which this course is offered:	Fourth Level / Second Year
4. Pre-requisites for this course (if any)**:**	Calculus (2) (code: 30112501-4)
5. Co-requisites for this course (if any)**:**	Does not exist.

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	**Traditional classroom**	4 hours per week	100%
2	**Blended**	0	0%
3	**E-learning**	0	0%
4	**Correspondence**	0	0%
5	**Other**	0	0%

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
Contact Hours		
1	**Lecture**	(4 hours) x (15 weeks)
2	**Laboratory/Studio**	0
3	**Tutorial**	0
4	**Others** (specify)	0
	Total	60
Other Learning Hours*		
1	**Study**	(1 hour) x (15 weeks)
2	**Assignments**	(1 hour) x (15 weeks)
3	**Library**	(1 hour) x (15 weeks)
4	**Projects/Research Essays/Theses**	0
5	**Others** (specify)	0
	Total	45

* The length of time that a learner takes to complete learning activities that lead to achievement of course learning outcomes, such as study time, homework assignments, projects, preparing presentations, library times

B. Course Objectives and Learning Outcomes

1. Course Description

Multivariable calculus is the third and the final part of the standard three-semester calculus sequence. It represent the extension of calculus in one variable to calculus with functions of several variables. This course treats topics related to differential calculus in several variables, integration in several variables and vector calculus. Multivariable calculus has many applications in various areas such as pure mathematics, engineering and physics.

2. Course Main Objective

The aim of this course is to provide students with fundamental concepts and techniques of multivariable calculus and to develop student understanding and skills for its applications to other areas.

3. Course Learning Outcomes

	CLOs	Aligned PLOs
1	**Knowledge:**	
1.1	Recognize mathematical formulas and methods of derivation of multivariable functions.	
1.2	State the integration techniques to calculate multiple integrals in different coordinate systems.	
1.3	Memorize the different theorems of vector calculus.	
2	**Skills :**	
2.1	Perform differential calculus operations on functions of several variables including continuity, partial derivatives and directional derivatives.	
2.2	Estimate multiple integrals in different coordinate systems including Cartesian, polar, cylindrical and spherical coordinates.	
2.3	Perform calculus operations on vector-valued functions.	
3	**Competence:**	
3.1	Apply the computational and conceptual principles of calculus to the solutions of various scientific applications.	
3.2	Use the most important theorems of vector calculus, such as the Fundamental Theorem of Line Integrals, Green's Theorem, the Divergence Theorem, and Stokes' Theorem, to simplify integration problems.	

C. Course Content

No	List of Topics	Contact Hours
1	**The Derivative in n-space** - Functions of several variables. - Partial Derivatives - Limits and continuity - Differentiability - Directional Derivatives - The Chain rule - Tangent planes. - Approximations - Maxima and minima - Lagrange's method	24
2	**The integral in n-space** - Double integrals over rectangles - Double integrals over nonrectangular regions - Double integrals in polar coordinates - Applications - Surface area	18

	- Triple integrals in Cartesian, cylindrical and spherical coordinates	
3	**Vector calculus** - Vector fields - Line integrals - Independence of path - Green's theorem - Surface integrals - Gauss's divergence theorem - Stokes's theorem	18
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge**		
1.1	Recognize mathematical formulas and methods of derivation of multivariable functions.	Lecture. Memorization.	Exams (Midterm and Final). Quizzes.
1.2	State the integration techniques to calculate multiple integrals in different coordinate systems.	Lecture. Memorization.	Exams (Midterm and Final). Quizzes.
	Memorize the different theorems of vector calculus.	Lecture. Memorization.	Exams (Midterm and Final). Quizzes.
2.0	**Skills**		
2.1	Perform differential calculus operations on functions of several variables including continuity, partial derivatives and directional derivatives.	Lecture. Small group work.	Exams (Midterm and Final). Homework.
2.2	Estimate multiple integrals in different coordinate systems including Cartesian, polar, cylindrical and spherical coordinates.	Lecture. Small group work.	Exams (Midterm and Final). Homework.
2.3	Perform calculus operations on vector-valued functions.	Lecture. Small group work.	Exams (Midterm and Final). Homework.
3.0	**Competence**		
3.1	Apply the computational and conceptual principles of calculus to the solutions of various scientific applications.	Lecture. Small group work.	Exams (Midterm and Final). Homework.
3.2	Use the most important theorems of vector calculus, such as the Fundamental Theorem of Line Integrals, Green's Theorem, the Divergence Theorem, and Stokes' Theorem, to simplify integration problems.	Lecture. Small group work.	Exams (Midterm and Final). Homework.

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Midterm Test (1)	6th week	20%
2	Midterm Test (2)	12th week	20%
3	Homework and Quizzes	During the semester	10%
4	Final Examination	End of semester	50%

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice:

Each group of students is assigned to a faculty member where he or she will provide academic advising. All faculty members are required to be in their offices outside teaching hours. Each faculty member allocates at least 4 hours per week to give academic advice and to answer to the questions of students about concepts studied during the lectures.

F. Learning Resources and Facilities

1.Learning Resources

Required Textbooks	Calculus with analytic geometry (4th Edition), Edwin J. Purcell, and Dale E. Varberg, Prentice Hall (1984).
Essential References Materials	Advanced engineering mathematics, Stanley I. Grossman, and William R. Derrick, Harper and Row, New York (1988).
Electronic Materials	None.
Other Learning Materials	None.

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	Large classrooms that can accommodate more than 50 students
Technology Resources (AV, data show, Smart Board, software, etc.)	Data Show.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None.

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment.	Students	Direct
Quality of learning resources.	Students	Direct
Extent of achievement of course learning outcomes.	Faculty member	Direct

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)
Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)
Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	Council of the Mathematics Department
Reference No.	
Date	