Course Specifications

Course Title:	**Differential Geometry**
Course Code:	**Math 463**
Program:	B.Sc. in Mathematics
Department:	**Mathematics**
College:	**Science**
Institution:	**King Abdulaziz University**

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A. Course Identification

1. Credit hours:	**3**
2. Course type	
a.	University ☐ College ☐ Department ■ Others ☐
b.	Required ■ Elective ☐
3. Level/year at which this course is offered:	**Level 8, Year 4**
4. Pre-requisites for this course (if any)**:**	**Calculus III (Math 203)**
5. Co-requisites for this course (if any)**:**	**None**

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	**Traditional classroom**	57	95%
2	**Blended**		
3	**E-learning**	3	5%
4	**Correspondence**		
5	**Other**		

7. Actual Learning Hours (based on academic semester)

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

* 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

- General introduction to the theory of curves in R^n

Parametrized curves, regular curves, tangent vector, arc-length, reparametrization, curvature.

- Theory of curves in R^2:
  Unit tangent vector, singular plane curve, singularity, unit normal vector, singed curvature of a plane curve (specific formula), inflection points, fundamental theorem of plane curve, evolutes and involutes.
- Theory of curves in R^3:

Tangent vector, principal normal vector and binormal vector, curvature, torsion, Serret – Frenet equations, fundamental theorem of space curve, spherical indicatrices, general helix, Bertrand curves.

- Theory of surfaces in R^3:
  Parametrized surface, regular parametrized surface, normal of regular surface, tangent plane, first and second fundamental forms, principal curvatures, Gaussian curvature, mean curvature, umbilical points, normal curvature, geodesic curvature, principal directions, Lines of curvature.

2. Course Main Objective

- The Course aims to give the students the basic principles, definitions and formulas of different differential geometry mathematical topics which related to curves and surfaces in space
- Introducing parametrization of plane curves and surfaces.
- Students should recognize specific definitions and formulas and apply them in problem solving materials.
- Students should recognize curves on surfaces and various types of curvatures and geodesics.
- Improving the logical thinking and imagination of students.
- Applying many techniques to solve mathematical problems.
- Improving the skills of the students for better understanding of partial differentiation and integration.

3. Course Learning Outcomes

	CLOs	Aligned PLOs
1	**Knowledge:**	
1.1	Chapter Zero: Recall the Three-Dimensional Coordinate System. Memorize and identify Vector properties. Chapter 3 3.1 Define Parametric representation of a curve, regular parametric representation, allowable change of parameter, singular point and a regular curve. 3.2 List examples of curves. 3.3 Identify the Orthogonal Projections. 3.4 write formulas of implicit differentiation of curves. 3.5 Introduce the meaning if class C^m. 3.6 Give Formulas and explain how to calculate: Arc Length of a curve.	
1.2	Chapter 4 4.1& 4.2 Identify and sketch the tangent vector. Give formulas of different kind of equations for the Normal plane. .	
2	**Skills :**	
2.1	4.3& 4.4 Discover and calculate the curvature of a curve and summarize connections to the first derivative of the vector function. 4.5 & 4.6 Design and construct the moving trihedron. 4.7 Construct formula to calculate Torsion. 4.7 Apply general formulas to evaluate Curvature and Torsion. 4.8 Summarize and describe spherical indicatrices.	
2.2	4.8 Explain how to give idea about local shape of a curve. 5.1 Design, justify contact between curves and surfaces. 5.1 Compose the Osculating Sphere regarding to number of point of contacts. 5.2 Reconstruct formulas to calculate center of curvature 5.3 Demonstrate the Tangent lines and perform Involute and Evolute of a curve C. 5.3 Develop and create Helices, then apply their geometrical significance to formulate curvature and torsion. 5.3 Construct Bertrand Curves and interpret its properties to modify their torsions. 8.1 Review Local differential geometry of surfaces. 8.1 Compare the curves on Surfaces. 9.2 Evaluate angle and Area of Surfaces. 8.2 Establish a new formula for the tangent plane equation by using the Normal vector. 9.1 9.3 Compose the First and Second Fundamental form to create a new kinds of curvature.	

CLOs		Aligned PLOs
	9.4 Build the Principal Curvature and Principal Directions.	
3	**Competence:**	
3.1	The Student is expected to carry out an independent investigation of the topic by studying the materials regularly, doing their homework on time, attending the lectures strictly and discuss their difficulties with their instructor.	
3.2	Interact with fellow students and instructor to obtain sufficient information and analyze this information to calculate and get logical conclusions.	

C. Course Content

No	List of Topics	Contact Hours
0	Chapter zero : Refresh some previous knowledge,	4
1	1.1General introduction to the theory of curves in the n-dimensional 1.2 Examples of curves. 1.3Orthogonal projections. 1.4 Implicit representations of curves. 1.5 Regular curves. 1.6 Tangent curves and Tangent vector. Arc length. parametrization.Curvature. Theory of curves in 2nd dimensional, Unit tangent vector.	14
2	2.1 Moving Trihedron. 2.2 Curvature. 2.3 Binormal moving trihedron. 2.4 Torsion. 2.5 General formulas for curvature and torsion. 2.6 Spherical indicatricies. 2.7 Local shape of curve. 2.8 Contact between curves and surfaces. 2.9 Osculating sphere. 2.10 Locus of center of curvature. 2.11Involutes and evolutes. 2.12 Helices. 2.13 Bertrand curves	28
3	3.1 Surfaces. 3.2 Curves on surfaces. 3.3 Angle and area. 3.4 Tangent plane and normal line. 3.5 Fundamental forms I and II 3.6 Principal curvature and principal directions. 3.7 Lines of curvature.	14

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	Chapter Zero: Recall the Three-Dimensional Coordinate System. Memorize and identify Vector properties. 1.1. Define Parametric representation of a curve, regular parametric representation, allowable change of parameter, singular point and a regular curve. 1.2 List examples of curves. 1.3 Identify the Orthogonal Projections. 1.4 write formulas of implicit differentiation of curves. 1.5 Introduce the meaning if class C^m. 1.6 Give Formulas and explain how to calculate :Arc Length of a curve.	• Lectures • Hand-outs • Textbooks • Kahoot • Class Discussion	• Home Work Assignments • In-Class Questions • Quizzes • MCQ Exams
1.2	2.1 Identify and sketch the tangent vector. Give formulas of different kind of equations for the Normal plane.	• Lectures • Hand-outs • Textbooks • Kahoot • Class Discussion	• Home Work Assignments • In-Class Questions • Quizzes • Written Exams
2.0	**Skills**		
2.1	2.2 Discover and calculate the curvature of a curve and summarize connections to the first derivative of the vector function. 2.3 Design and construct the moving trihedron. 2.4 Construct formula to calculate Torsion. 2.5 Apply general formulas to evaluate Curvature and Torsion. 2.6 Summarize and describe spherical indicatrices.	• Small group work • Discussion and debate.	• Peer assessment • self-assessment • written exams

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
2.2	2.7 Explain how to give idea about local shape of a curve. 2.8 Design, justify contact between curves and surfaces. 2.9 Compose the Osculating Sphere regarding to number of point of contacts. 2.10 Reconstruct formulas to calculate center of curvature 2.11 Demonstrate the Tangent lines and perform Involute and Evolute of a curve C. 2.12 Develop and create Helices, then apply their geometrical significance to formulate curvature and torsion. 2.13 Construct Bertrand Curves and interpret its properties to modify their torsions. 3.1 Review Local differential geometry of surfaces. 3.2 Compare the curves on Surfaces. 3.3 Evaluate angle and Area of Surfaces. 3.4 Establish a new formula for the tangent plane equation by using the Normal vector. 3.5 Compose the First and Second Fundamental form to create a new kinds of curvature. 3.6 Build the Principal Curvature and Principal Directions. 3.7 Design the lines of Curvature.	• Group work • Problem solving	• In-class activity • written exams
3.0	**Competence**		
3.1	The Student is expected to carry out an independent investigation of the topic by studying the materials regularly, doing their homework on time, attending the lectures strictly and discuss their difficulties with their instructor.	• Group discussion • Feedback of oral and written exams • Encourage the students for teamwork activities	• Oral exams • Presentation • Summarizing • Self-readings

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
3.2	Interact with fellow students and instructor to obtain sufficient information and analyze this information to calculate and get logical conclusions.	• Small group work • Brain storming • Students practice some uncovered examples	• Peer review • In-class activities • presentation
…			

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Exam 1	7th week	30%
2	Exam 2	12th week	30%
3	Home Work	Weekly-Distributed through the semester	3 % Bonus
4	Final Exam	16th week	40%
	Total		100%

***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 :

The instructor is available for at least six hours per week and through e-mails.

F. Learning Resources and Facilities

1.Learning Resources

Required Textbooks	Differential Geometry (Schaum's outline) Martin Lipschutz
Essential References Materials	1- An Introduction to Differential Geometry T.J.Willmore 2- Introduction to Differential Geometry and Riemannian Geometry Erwin Kreyszig 3- Differential and Riemannian Geometry Detlef Laugwitz 4-Differential Geometry with Applications to Mechanics and Physics. Marcel Dekker, Inc., 2000
Electronic Materials	Khan Academy and Youtube.
Other Learning Materials	• Syllabus • Rules and regulations of the course and faculty • Lecture hand-outs.

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	• Class room with capacity of 40-60 students • Wide White board in a large size.
Technology Resources (AV, data show, Smart Board, software, etc.)	• Data show projectors. • Smart Board
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
Obtaining Student Feedback on Effectiveness of Teaching.	By the Instructor	• Discussion at the end of the lecture • Course evaluation survey • The instructor distribute a survey by himself to get feedback about his

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Other Strategies for Evaluation of Teaching.	By the Instructor or by the Department.	teaching on the spot from the students • Discussion after feedback • Peer review • In case of a common course, the coordinator must obtain the feedback of the whole faculty students that involved in the course and submit her/his report to the chairman of the department • The chairman must try to implement the suggestions raised by the coordinator to improve the course. • Reports of optional courses have to be analyzed carefully and proper actions have to be taken. • In this semester the instructor distributed her own survey by the 13th week to see what actions are needed to be changed, added or stopped.

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	
Reference No.	
Date	