Course Specification
(Bachelor)

Course Title:	**Introduction to Differential Geometry**
Course Code:	**MAT 1384**
Program:	**Bachelor of Science in Applied Mathematics**
Department:	**Mathematics and Statistics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	**2024 – V1**
Last Revision Date:	**08/10/2024**

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A. General information about the course:

1. Course Identification

1. Credit hours:					
3 (2 Lectures, 0 Lab, 2 Tutorial)					
2. Course type					
A.	☐University	☐ College	☒ Department	☐Track	☐Others
B.	☒ Required		☒ Elective		
3. Level/year at which this course is offered:					
Level 6 / Year 3 or Level 7 / Year 4					
4. Course general Description:					
Introduction to Differential geometry is an elective course. It introduces the subject by focusing on those geometries which are easiest to visualize: curves and surfaces in three-dimensional space. Regarding surfaces, the course gives a detailed properties which are intrinsic to the geometry of surfaces in the sense that they only depend on how distance is measured. Most of the properties will be local in nature (e.g. curvature) ultimately building up to the Gauss-Bonnet Theorem which relates those local properties to global characteristics of the surface.					
5. Pre-requirements for this course (if any):					
MAT 1203					
6. Co-requisites for this course (if any):					
None.					
7. Course Main Objective(s):					
Frequently, in science, engineering and economics, it is required to estimate certain quantities so that the system, device or plan not only meets a required set of specifications but is also the best in terms of certain figure of merit. This is exactly what we call differential geometry problem and finding analytical solution to this kind of problems is not always possible. Thus, differential geometry becomes considerably important for solving such problems. This course aims at training students for acquiring a basic mathematical understanding of modern approaches to the study of geometry of Plane curves and Regular Surfaces in R^3 and discussing practical aspects of the implementation for solving differential geometry problems.					

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	E-learning	0	0%
3	Hybrid	0	0%

No	Mode of Instruction	Contact Hours	Percentage
	• Traditional classroom • E-learning		
4	Distance learning	0	0%

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	30
2.	**Laboratory/Studio**	
3.	**Field**	0
4.	**Tutorial**	30
5.	**Others (specify)**	0
Total		60

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	**To Demonstrate the ability to recall the the Curves' and Surfaces' parameterizations, and the Global properties of curves and surfaces.**	**K1, K2**	**●3 lecture hours\week**	**●Regular Exams**
1.2	**To Be familiar with differential of the Gauss map, and the first and second fundamental forms of a regular surfaces.**	**K1, K2**	**●2 tutorial hours\week ●Self-study**	**●Assignments ●Short Quizzes**
2.0	**Skills**			
2.1	**To demonstrate ability to think critically and analytically when solving problems in**	**S1, S2**	**Real-life problems**	**Short Quizzes**

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
	class, on homework, and on exams.			
2.2	To express themselves in mathematical terms and concepts when writing solutions to problems on homework and exams, as well as in in-class discussions.	S4	Self-study	Participations
2.3	To locate and use information to understand and solve homework problems.	S5	Real-life problems	Short Quizzes
2.4	To Demonstrate ability to integrate knowledge of mathematics in a coherent and meaningful manner and apply it to new problems.	S3	Self-study	Participations
3.0	Values, autonomy, and responsibility			
3.1	To listen to the teacher's explanation of Mathematics reasoning and illustration.	V1, V3	Personal questions	Participation
3.2	To show attitude of Working in different groups and communicate results to other.	V1, V2	Team work	Homework and Mini-projects

C. Course Content

No	List of Topics	Contact Hours
1.	**Geometry of curves:** parameterizations; arc length; curvature; torsion; Frenet equation; the local canonical form; global properties of curves in the plane.	**12**
2.	**Geometry of surfaces in R^n**: parameterizations; tangent plane; differential; first and second fundamental forms; the geometry of the Gauss map; curves in surfaces; tangent plane; tangent space and normal vectors.	**16**
3.	**Geometry of geodesics:** normal and geodesic curvature of curves; exponential map; geodesic polar coordinates; Fermi coordinates; properties of geodesics, Jacobi fields; convex neighborhoods.	**16**
4.	**Global results about surfaces:** The Gauss Theorem, The Gauss-Bonnet Theorem; Hopf-Rinow theorem; cut points and conjugate points; The Bonnet-Myers Theorem.	**16**
Total		**60**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	HomeWorks, Quizzes, Mini-projects	During the term	10%
2.	First Midterm	Week 5-6	25%
3.	Second Midterm	Week 10-11	25%
4.	Final Exam	Week 15-16	40%

*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	*Differential Geometry of Curves and Surfaces*, **Manfredo P. do Carmo, Prentice Hall, Inc., New Jersey, 1976 (Main textbook)**
Supportive References	1. *Differential Geometry of Curves and Surfaces*, **Thomas F. Banchoff, Stephen T. Lovett, CRC Press, 2010.** 2. *Elementary Differential Geometry*, **Barret O'Neill, Academic Press, 1966.** 3. *Lectures on Classical Differential Geometry*, **Dirk J. Struik, Dover Publ., 1988.** 4. *Elementary Topics in Differential Geometry*, **John A. Thorpe, Springer, 2011.**
Electronic Materials	**None**
Other Learning Materials	**None**

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	• **Classrooms:** Equipped with whiteboards, projectors, and Smart Boards for interactive lessons and group discussions. • **Laboratories:** Feature computers with internet access, enabling hands-on activities and exploration of algebraic and trigonometric concepts. • **Exhibition Rooms:** Spaces for showcasing projects and presentations to encourage collaborative learning.
Technology equipment (projector, smart board, software)	• **Data Show Projectors:** For clear presentations in classrooms and labs. • **Smart Boards:** To enhance interactivity during lessons. • **Mathematical Software:** Essential for graphing and analysis.
Other equipment (depending on the nature of the specialty)	• **Computers:** For mini-project and homework and practical applications in laboratories. • **Advanced Calculators:** For computations and problem-solving and supporting the study of limits, continuity, and differentiation. • **Whiteboards and Markers:** To facilitate brainstorming and collaboration.

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Faculty, Program Manager, Students, Course Coordinator	- **Student Course Evaluation**: Student feedback surveys to assess teaching quality (clarity, engagement, delivery). - **Instructor Course Report**: Instructor reflection on their teaching effectiveness and challenges. - **Classroom Observations**: Conducted by the program manager or course coordinator to directly observe teaching methods. - **Benchmarking Between Male and Female Sections**: Compare student evaluations and performance across gender-based sections to identify any disparities in teaching effectiveness. - **Advisory Board Feedback**: Gathering insights on teaching methods from external academic or industry professionals.
Effectiveness of Students assessment	Faculty, External Reviewers, Program Manager, Course Coordinator	- **Alignment of Assessments with CLOs**: Ensuring exams, assignments, and projects measure the intended CLOs. - **Benchmarking Between Semesters**: Comparing assessment effectiveness across different semesters to maintain consistency and improvement. - **CLOs Assessment Excel Sheet**: Tracking student performance in relation to CLOs to evaluate the strength of assessments. - **Instructor Course Report**: Faculty analysis of assessment outcomes and potential adjustments. - **External Audit/Reviewers**: External examiners review assessments for rigor and fairness.

Assessment Areas/Issues	Assessor	Assessment Methods
Quality of learning resources	Program Manager, Librarians, Faculty, Course Coordinator	- **Student Course Evaluation**: Students provide feedback on the usefulness and availability of learning resources (textbooks, software, etc.). - **Instructor Course Report**: Faculty report on the adequacy and relevance of learning materials. - **Resource Usage Statistics**: Data on the usage of learning resources (digital/physical) such as library access, software downloads. - **Benchmarking Between Sections/Semesters**: Compare resource satisfaction across male/female sections and over semesters. - **Advisory Board Input**: External experts suggest updated or alternative resources to align with industry or academic developments.
The extent to which CLOs have been achieved	Faculty, Program Manager, External Reviewers, Course Coordinator	- **CLOs Assessment Excel Sheet**: Regular tracking of student performance for each CLO based on exams, projects, and assignments. - **Instructor Course Report**: Faculty reflection on CLO achievement and any gaps identified. - **Student Course Evaluation**: Students assess whether they feel they've met the course learning outcomes. - **Benchmarking Between Semesters**: Analyze CLO achievement across different semesters to ensure continuous improvement. - **Advisory Board Feedback**: Assess whether CLOs are aligned with industry or academic standards and if students are adequately prepared.
Other	**None**	

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

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	**MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL**
REFERENCE NO.	**8/1446**
DATE	**05/04/1446 (08/10/2024)**