# King Fahd University of Petroleum & Minerals
## Mathematics Department
## Math 583 – Syllabus
### Semester 231

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| Course Number | MATH 583 |
| Course Title | Computer Graphics: Modeling and Processing |
| Course Main Objectives | . Provide a thorough overview of methods for generating free form curves and surfaces<br>. Assessing 3D Models quality<br>. Provide basic mathematical concepts in computer graphics and geometric modeling and processing |
| Course Leaning Outcomes | **By the end of this course, students will be able to:**<br>1- Explain the fundamentals of geometric modeling and processing<br>2- Analyze and describe geometric shapes related to computer graphics<br>3- Apply algorithms for generating free form curves and surfaces<br>4- Use methods for interpolation, approximation as well as subdivision algorithms<br>5- Assess and analyze the quality of designed 3D models<br>6- Create meshes from point cloud |
| Catalog Course Description | This course introduces central concepts of geometric modeling, basic shape representations (parametric and implicit curves and surfaces, meshes, point clouds), freeform curve and surface design in spline representation, subdivision surfaces, surface quality assessment, geometry processing on meshes. |
| Pre-Requisites | Graduate Standing |

**TEXTBOOK:**

- Farin, Gerald E., *Curves and surfaces for CAGD: a practical guide.* Morgan Kaufmann, 2002.

**REFERENCES:**

- Liao, Wenhe, Hao Liu, and Tao Li. *Subdivision Surface Modeling Technology*. Springer Singapore, 2017.
- Botsch, M., Kobbelt, L., Pauly, M., Alliez, P., & Lévy, B. (2010). *Polygon mesh processing*. CRC press.
- Bærentzen, J. Andreas, et al. *Guide to computational geometry processing: foundations, algorithms, and methods*. Springer Science & Business Media, 2012.

**ASSESSEMENT:**

- Assignments: 25%
- Project: 20%
- Major Exam: 25%
- Final Exam: 30% (Comprehensive)

**OFFICE HOURS:** Monday and Wednesday 10:00 am-- 12:00 am (or by Appointment)

**COURSE OUTLINE**

**1- Bézier curves (7 hours)**
de Casteljau Algorithm, Subdivision, Blossom, degree elevation, Interactive design.
**Implementation:** Interactive Bézier curve drawing in 2D and 3D

**2- B-spline Curves (5 hours)**
Composite Bézier curves, B-spline construction and interpolation.
**Implementation**: B-spline curve editor, B-spline curve fitting algorithms, Interactive B-spline curve animation

**3- Rational Bézier and B-spline Curves (3 hours)**
Bézier representation of rational functions, composite rational Bézier curves
**Implementation**: Free-form design with interactive NURBS

**4- Tensor Product Patches (6 hours)**
Bilinear interpolation, de Casteljau algorithm, Blossom, Composite surfaces, B-spline surfaces.
**Implementation**: Free-form surface design with B-spline surfaces using point clipping

**5- Bezier Triangles (6 hours)**
Bernstein polynomials, de Casteljau algorithm, Triangular blossom, Clough-Tocher and Powell-Sabin interpolants
**Implementation**: Algorithms for Clough-Tocher and Powell-Sabin interpolant and application in design

**6- Shape Assessment (6 hours)**
Curvature plots, Curves and surfaces smoothing, Surface interrogation
**Implementation**: Surface interrogation using discrete Gaussian and mean curvatures

**7- Subdivision Curves and Surfaces (6 hours)**
Catmull-Clark, Doo-Sabin, Loop and butterfly subdivisions
**Implementation**: Shape design using subdivision curves and surfaces

**8- Geometry Processing on Meshes (6 hours)**
Point cloud meshing, mesh simplification and parametrization
**Implementation**: Constructing meshes from point clouds and meshes processing

**All the implementations will be performed using the Python Package of the IBM SPSS**