Degree competences to which the subject contributes

Specific:
D33. Knowledge of aesthetics.
D48. Ability to know and apply creative process and its organization.

Transversal:
2. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.
4. EFFECTIVE USE OF INFORMATION RESOURCES. Managing the acquisition, structure, analysis and display of information from the own field of specialization. Taking a critical stance with regard to the results obtained.
05 TEQ N2. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.
05 TEQ N1. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.

Teaching methodology
There are large group classes, that deal with theoretical explanations, descriptions of selected examples and problem solving (by hand, with computer and smartphone). In the computer lab sessions, students work with Geogebra in order to work the theoretical concepts and prepare graphical projects.

Learning objectives of the subject
* To understand the concepts and techniques of classical geometry that are essential for CAGD:
  - To use affine coordinates and transformations to move and transform the shape of plane and spacial geometric figures
  - To handle with conics and quadric surfaces, as example of basic curves and surfaces
  - To understand the following concepts of differential geometry: curvature, torsion and osculating circle of a curve; tangent plane, normal vector and Dupin indicatrix of a surface
* To use the techniques of Bézier designing curves and surfaces:
- To deal with Bernstein polynomials for Bézier curves and surfaces
- To learn the de Casteljau Algorithm
- To understand the problem of geometric continuity for Bézier curves and surfaces

### Study load

<table>
<thead>
<tr>
<th>Study load</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total learning time</td>
<td>150h</td>
<td></td>
</tr>
<tr>
<td>Hours large group</td>
<td>45h</td>
<td>30.00%</td>
</tr>
<tr>
<td>Hours medium group</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Hours small group</td>
<td>15h</td>
<td>10.00%</td>
</tr>
<tr>
<td>Guided activities</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Self study</td>
<td>90h</td>
<td>60.00%</td>
</tr>
<tr>
<td>Content</td>
<td>Learning time: 8h</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>------------------</td>
<td></td>
</tr>
<tr>
<td>1. Review of basic geometry</td>
<td>Theory classes: 2h</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 2h</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Self study : 4h</td>
<td></td>
</tr>
</tbody>
</table>

**Description:**
1. Plane geometry: parallelism, perpendicularity, distance
2. Space geometry: lines, planes, parallelism, perpendicularity, distance

**Related activities:**
Activities 1, 2, 3, 4 & 6

<table>
<thead>
<tr>
<th>Content</th>
<th>Learning time: 36h</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Differential Geometry of curves</td>
<td>Theory classes: 10h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study : 24h</td>
</tr>
</tbody>
</table>

**Description:**
1. Regular parametrizations
2. Conics
3. Curvature and torsion
4. Osculating circle and evolutes
5. Frenet frame
6. Geometric continuity

**Related activities:**
Activities 1, 6
### 3. Differential Geometry of Surfaces

**Description:**
- 1. Regular parameterizations
- 2. Cuádricas
- 3. Surfaces of revolution
- 4. Ruled surfaces
- 5. Tangent plane
- 6. Gaussian, normal and mean curvature
- 7. Dupin's indicatrix
- 8. Offset surfaces
- 9. Tubular surfaces

**Related activities:**
Activities 2, 6

**Learning time:**
- Theory classes: 6h
- Laboratory classes: 2h
- Self study: 16h

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### 4. Affine maps

**Description:**
- 1. Affine combinations. Barycentric coordinates
- 2. Plane transformations
- 3. Mosaics
- 4. Space transformations

**Related activities:**
Activities 3, 6

**Learning time:**
- Theory classes: 6h
- Laboratory classes: 2h
- Self study: 12h
### 5. Bézier curves

**Description:**
1. Definition and basic properties
2. Casteljau's algorithm
3. Subdivision
4. Geometric continuity

**Related activities:**
Activities 4, 6

**Learning time:** 32h
- Theory classes: 10h
- Laboratory classes: 2h
- Self study: 20h

### 6. Bezier Surfaces

**Description:**
1. Definition and basic properties
2. De Casteljau's algorithm
3. Subdivision
4. Geometric continuity
5. Coon's patches

**Related activities:**
Activities 5, 6

**Learning time:** 20h
- Theory classes: 6h
- Laboratory classes: 2h
- Self study: 12h
### Planning of activities

<table>
<thead>
<tr>
<th>PROJECT</th>
<th>Description</th>
<th>Hours</th>
<th>Laboratory classes</th>
<th>Self study</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <strong>PROJECT 1</strong>: Differential Geometry of curves</td>
<td>Designing a roller coaster with Geogebra</td>
<td>4h</td>
<td>2h</td>
<td>2h</td>
</tr>
<tr>
<td>2. <strong>PROJECT 2</strong>: Differential Geometry of Surfaces</td>
<td>Moving an object on a surface with Geogebra</td>
<td>4h</td>
<td>2h</td>
<td>2h</td>
</tr>
<tr>
<td>3. <strong>PROJECT 3</strong>: Mosaics</td>
<td>Design of a mosaic with Geogebra</td>
<td>6h</td>
<td>2h</td>
<td>4h</td>
</tr>
<tr>
<td>4. <strong>PROJECT 4</strong>: Animation</td>
<td>Design of an animation with Geogebra</td>
<td>12h</td>
<td>2h</td>
<td>10h</td>
</tr>
<tr>
<td>5. <strong>PROJECT 5</strong>: Composition 3D</td>
<td>Design of a composition 3D with Geogebra</td>
<td>8h</td>
<td>2h</td>
<td>6h</td>
</tr>
<tr>
<td><strong>6. FINAL EXAM</strong></td>
<td>Exam: Problems and theoretical questions of topics 1, 2, 3, 4, 5 and 6</td>
<td>2h</td>
<td>Theory classes: 2h</td>
<td></td>
</tr>
</tbody>
</table>
Ongoing assessment (OA): 0.15*NA1 + 0.15*NA2 + 0.15*NA3 + 0.3*NA4 + 0.25 NA5
NA1, NA2, NA3, NA4, NA5: Projects (activities 1, 2, 3, 4, 5)
NA6: Final exam (activity 6)
Final assessment: max(OA, 0.3*OA + 0.7*NA6)

Final exam is re-evaluable

Activities 1, 2, 3, 4 and 5 are done in pairs, and must be delivered in the dates fixed at the beginning of the course. Activity 6 is a standard exam.

Bibliography

Basic:

Complementary:

Others resources:
- Geogebra (https://www.geogebra.org/)
- Geogebra page of the course (https://www.geogebra.org/m/da8xM4JG)