

Academic Year: 2025/26

## 201981 - Materials and Lighting

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### Teaching Guide Information

**Subject code:** 201981

**Degree program:** 10014 - Degree in Digital Creation, Animation and Video Games

**Type:** Compulsory

**Year:** 1

**Number of ECTS:** 6.0

**Period:** Second term

**Languages:**

**Degree coordination:** Patricia Comesaña Comesaña

**Subject coordination:** Aldán Delgado Fernández

**Faculty:** Aldán Delgado Fernández

### 1. Overview

The objective of this subject is for students to know the image generation process through computer (render). Students will be able to analyze the optic properties of materials to reproduce them in synthetic images through various illumination techniques. They will be also capable of applying images as texture to control the different material properties. We will learn to create and configure virtual cameras for synthetic image generation, emulating the real camera behaviour.

### 2. Educational and learning outcomes (RD 822/2021 degree programs) or competences (RD 1393/2007 degree programs)

#### Competences (RD 1393/2007 degree programs)

- **[A10]** CE10 - Conocer las etapas principales del pipeline de una producción de animación o videojuego y su importancia dentro del proceso global.
- **[A11]** CE11 - Saber definir las propiedades de los materiales asignados a los objetos de una escena 3D, incluyendo el uso de las técnicas de mapeado de texturas y conocer las diferentes técnicas de iluminación y render para la generación de imágenes por computador utilizadas en animación y videojuegos. Saber evaluar el coste de las diferentes técnicas de iluminación y shading, de cara a la toma de decisiones en una producción.
- **[B01]** CB1 - Que os estudantes demostrasen posuír e comprender coñecementos nunha área de estudo que parte da base da educación secundaria xeral, e se atope a un nivel que, se ben se apoia en libros de texto avanzados, inclúe tamén algúns aspectos que implican coñecementos procedentes da vangarda do seu campo de estudo
- **[B02]** CB2 - Que los estudiantes sepan aplicar sus conocimientos a su trabajo o vocación de una forma profesional y posean las competencias que suelen demostrarse por medio de la elaboración y defensa de argumentos y la resolución de problemas dentro de su área de estudio

- **[B03]** CB3 - Que los estudiantes tengan la capacidad de reunir e interpretar datos relevantes (normalmente dentro de su área de estudio) para emitir juicios que incluyan una reflexión sobre temas relevantes de índole social, científica o ética
- **[B04]** CB4 - Que los estudiantes puedan transmitir información, ideas, problemas y soluciones a un público tanto especializado como no especializado
- **[B05]** CB5 - Que los estudiantes hayan desarrollado aquellas habilidades de aprendizaje necesarias para emprender estudios posteriores con un alto grado de autonomía
- **[B06]** CG1 - Capacidad de organización y planificación. Especialmente en el planteamiento de trabajos conducentes a la creación de los contenidos audiovisuales digitales que componen una producción de animación o un videojuego.
- **[B07]** CG2 - Capacidad de resolver problemas de forma efectiva, principalmente de carácter tecnológico y en el campo de la creación de contenidos digitales interactivos y de animación.
- **[B08]** CG3 - Conocimientos informáticos, en especial los relativos al uso de tecnologías y programas de última generación en el campo de estudio.
- **[B09]** CG4 - Conocer los procedimientos, destrezas y metodologías necesarios para la adaptación del proceso creativo al medio digital y la producción de obras artísticas a través de tecnologías específicas.
- **[B10]** CG5 - Valorar críticamente el conocimiento, la tecnología y la información disponible para su aplicación en la resolución de problemas.
- **[B11]** CG6 - Capacidad crítica y autocrítica. Necesaria en todo proceso creativo en el que se busca un compromiso con la calidad del trabajo, los resultados y las soluciones propuestas.
- **[B12]** CG7 - Trabajo en equipo. Capacidad de abordar proyectos en colaboración con otros estudiantes, asumiendo roles y cumpliendo compromisos de cara al grupo.
- **[B13]** CG8 - Capacidad de aplicar los conocimientos en la práctica, integrando las diferentes partes del programa, relacionándolas y agrupándolas en el desarrollo de productos complejos.
- **[C01]** CT1 - Adequate oral and written expression in the official languages.
- **[C03]** CT3 - Using ICT in working contexts and lifelong learning.
- **[C04]** CT4 - Acting as a respectful citizen according to democratic cultures and human rights and with a gender perspective.
- **[C06]** CT6 - Acquiring skills for healthy lifestyles, and healthy habits and routines.
- **[C07]** CT7 - Developing the ability to work in interdisciplinary or transdisciplinary teams in order to offer proposals that can contribute to a sustainable environmental, economic, political and social development.
- **[C08]** CT8 - Valuing the importance of research, innovation and technological development for the socioeconomic and cultural progress of society.
- **[C09]** CT9 - Ability to manage times and resources: developing plans, prioritizing activities, identifying critical points, establishing goals and accomplishing them.

## 2.1. Learning outcomes (RD 1393/2007 degree programs)

| Learning outcomes                                                                                                                 | Competences /<br>Results of the degree |                                                                                |                                        |
|-----------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|--------------------------------------------------------------------------------|----------------------------------------|
| To define the properties of 3D surface materials simulating different aspects, searching for realism as well as stylized results. | A10<br>A11                             | B1<br>B2<br>B3<br>B4<br>B5<br>B6<br>B7<br>B8<br>B9<br>B10<br>B11<br>B12<br>B13 | C1<br>C3<br>C4<br>C6<br>C7<br>C8<br>C9 |
| To master the use of different types of textures to control the properties of materials.                                          | A10<br>A11                             | B1<br>B2<br>B3<br>B4<br>B5<br>B6<br>B7<br>B8<br>B9<br>B10<br>B11<br>B12<br>B13 | C1<br>C3<br>C4<br>C6<br>C7<br>C8<br>C9 |

|                                                                                                                                                                                                                                                         |            |                                                                                |                                        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------------------------------------------------------------------------------|----------------------------------------|
| To know how to illuminate a 3D scene in different situations and with different aesthetic ends, realistically and non-realistically, in off-line render as well as in real time.                                                                        | A10<br>A11 | B1<br>B2<br>B3<br>B4<br>B5<br>B6<br>B7<br>B8<br>B9<br>B10<br>B11<br>B12<br>B13 | C1<br>C3<br>C4<br>C6<br>C7<br>C8<br>C9 |
| To have the ability to evaluate different illumination techniques, shading and texturizing considering their performance, quality and cost in render time, in regards to decision-taking in a production, or its adequacy to a real-time render engine. | A10<br>A11 | B1<br>B2<br>B3<br>B4<br>B5<br>B6<br>B7<br>B8<br>B9<br>B10<br>B11<br>B12<br>B13 | C1<br>C3<br>C4<br>C6<br>C7<br>C8<br>C9 |

### 3. Contents

| Content unit | Description                                                                                                                                                                                                                 | Education and learning outcomes / competences | Teaching methodologies and training activities | Assessment systems |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|------------------------------------------------|--------------------|
| Topic        | The shading process. Direct illumination:<br>Light-object interaction. Basic illumination models.<br>Properties of materials.<br>Light sources.                                                                             |                                               |                                                |                    |
| Topic        | Textures:<br>Types of textures<br>Applications of textures<br>Simulation of geometric details through textures                                                                                                              |                                               |                                                |                    |
| Topic        | PBR:<br>Physically correct materials.<br>Reflection, transmission, dispersion and absorption.<br>BRDF<br>Workflows PBR. Metalness/roughness, specular/glossiness<br>Metals and dielectrics                                  |                                               |                                                |                    |
| Topic        | Management of color and digital image:<br><br>Physical principles of color.<br>Color spaces.<br>Digital representation of information.<br>Dynamic range.<br>Gamma correction.<br>Image formats.<br>Lineal workflow.<br>ACES |                                               |                                                |                    |
| Topic        | Illumination principles:                                                                                                                                                                                                    |                                               |                                                |                    |

| Content unit | Description                                                                                                                                                                                                                                        | Education and learning outcomes / competences | Teaching methodologies and training activities | Assessment systems |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|------------------------------------------------|--------------------|
|              | Objectives of illumination.<br>Light characteristics.<br>Types of lights.<br>Light modelling.<br>Three-point lighting.<br>Classic illumination schemes.                                                                                            |                                               |                                                |                    |
| Topic        | Ray tracing:<br><br>Ray tracing algorithm.<br>Types of rays.<br>Reflections, refractions and shades.<br>Ray depth.                                                                                                                                 |                                               |                                                |                    |
| Topic        | Render:<br><br>Render techniques. Render off-line and real time rendering.<br>Path tracing<br>Aliasing and antialiasing<br>Render layers and render passes (AOVs)<br>Noise reduction techniques (denoising)                                        |                                               |                                                |                    |
| Topic        | Camera:<br><br>Camera functioning<br>Real camera parameters<br>CGI Cameras<br>Depth of field<br>Motion Blur                                                                                                                                        |                                               |                                                |                    |
| Topic        | Shadows:<br><br>Importance of shadows.<br>CGI shadow calculation techniques. Ray tracing and depth shadow maps                                                                                                                                     |                                               |                                                |                    |
| Topic        | Global illumination:<br><br>Simulating different light behaviors<br>Diffuse interreflections<br>Caustics<br>The render equation<br>Subsurface scattering (SSS). BRDF, BTDF, BSDF, BSSRDF<br>Ambient occlusion<br>Final gathering<br>Photon mapping |                                               |                                                |                    |

#### 4. Teaching methodologies and training activities

| Modality In-person             |                                                                                                                                                                                                                                                                     |                          |                        |                         |                                               |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|------------------------|-------------------------|-----------------------------------------------|
| Methodology                    | Description                                                                                                                                                                                                                                                         | In-person teaching hours | Virtual teaching hours | Independent study hours | Education and learning outcomes / competences |
| Personalized attention [MAG00] | Tutorings will complement workshops, theoretical classes and personal work, so that the doubts and difficulties that have appeared during classes can be solved, study or non-presential works. This tutorings can be done individually as well as in small groups. | 1,00                     | 0,00                   | 0,00                    |                                               |

| Methodology                       | Description                                                                                                     | In-person teaching hours | Virtual teaching hours | Independent study hours | Education and learning outcomes / competences                                                                 |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------|--------------------------|------------------------|-------------------------|---------------------------------------------------------------------------------------------------------------|
| Workshop [MAG16]                  | Lab work, problem resolution applying the concepts studied in theory in a 3D digital content creation software. | 47,00                    | 0,00                   | 100,00                  | A10, A11, B01, B02, B03, B04, B05, B06, B07, B08, B09, B10, B11, B12, B13, C01, C03, C04, C06, C07, C08, C09. |
| Multiple-choice questions [MAG30] | Theoric exam.                                                                                                   | 2,00                     | 0,00                   | 0,00                    | A10, A11, B01, B02, B03, B04, B05, B06, B07, B08, B09, B10, B11, B13, C01, C03, C09.                          |
| Sum of hours by type              |                                                                                                                 | 50,00                    | 0,00                   | 100,00                  |                                                                                                               |
| Total hours                       |                                                                                                                 |                          |                        | 150,00                  |                                                                                                               |

## 5. Assessment

| Modality In-person                |                                         |               |                                                                                                               |
|-----------------------------------|-----------------------------------------|---------------|---------------------------------------------------------------------------------------------------------------|
| Assessment system                 | Description                             | Weighting (%) | Education and learning outcomes / competences                                                                 |
| Workshop [SEG16]                  | Practical tasks (continuous assessment) | 70,00         | A10, A11, B01, B02, B03, B04, B05, B06, B07, B08, B09, B10, B11, B12, B13, C01, C03, C04, C06, C07, C08, C09. |
| Multiple-choice questions [SEG30] | Theoric exam                            | 30,00         | A10, A11, B01, B02, B03, B04, B05, B06, B07, B08, B09, B10, B11, B13, C01, C03, C09.                          |
| Total (%)                         |                                         | 100,00        |                                                                                                               |

All aspects related to academic exemption, study dedication, retention, and academic fraud will be governed in accordance with the current [academic regulations](#) of the UDC.

### 5.1. First opportunity

Subject evaluation is composed of two blocks, with the following weights in the final grade:

- Practical works: 70
- Theoric exam: 30

The theoric exam will be done in the official date of the subject exam.

Regarding practical works, the deadlines and evaluation criteria of each work will be notified previously in class and published in Moodle during the quatrimester.

Students who are in specific modalities of learning and attention to diversity will have the obligation to do all the practical works and deliver them in the specified dates. The evaluable works and final theoric exam have been designed to cater and encompass a broad spectrum of diversity. If it was necessary and always under previous demand of the students; the necessary adaptations will be established in order to not affect the students' qualification.

All aspects related to permanence and academic fraud will be conducted according to the UDC's current academic rules.

## 5.2. Second opportunity

In the re-sit, the practical work blocks will be substituted with a practical exam to be done in the lab in the official exam date. Therefore, the evaluation of the subject in the re-sit procedure will be composed of two blocks, with the following weights in the final grade:

- Practical exam: 70 %
- Theoric exam: 30 %

All aspects related to permanence and academic fraud will be conducted according to the UDC's current academic rules.

## 5.3. Early opportunity

In the early opportunity, as in the re-sit procedure, the practical work blocks will be substituted with a practical exam to be done in the lab in the official exam date. Therefore, the evaluation of the subject in the re-sit procedure will be composed of two blocks, with the following weights in the final grade:

- Practical exam: 70 %
- Theoric exam: 30 %

All aspects related to permanence and academic fraud will be conducted according to the UDC's current academic rules.

## 5.4. Academic exemption

All aspects related to academic exemption and/or dedication to studies will be conducted following the UDC's current academic rules.

Students with academic exemption will have the same subject evaluation criteria, that is, it will be comprised of two blocks, with the following weights in the final grade:

- Practical work: 70%
- Theoric exam: 30%

Activities will be adapted always having in consideration the evaluation observations about attendance flexibility, participation and deadlines of continuous evaluation.

## 6. Recommended bibliography

### Basic bibliography

- Alton, John. (2013). Painting with light. California University Press. Book. [\[URL\]](#)
- Birn, Jeremy. (2014). [Digital] lighting and rendering. New Riders, 3rd edition.. Book. [\[URL\]](#)
- Demers, Owen. (2001). Digital texturing & painting. New Riders. Book. [\[URL\]](#)
- Möller, Thomas., Hoffman, Naty.; Haines, Eric. (2018). Real-time rendering. CRC Press, 4th ed.. Book. [\[URL\]](#)
- Pharr, Matt, autor., Humphreys, Greg, autor.; Jakob, Wenzel, autor. (2023). Physically based rendering : from theory to implementation. The MIT Press, Fourth edition. Book. [\[URL\]](#)

### Supplementary bibliography

- Brown, Tim H. (2007). The art of Maya : an introduction to 3D computer graphics. Autodesk, 4th ed.. Book. [\[URL\]](#)
- Cantor, Jeremy., Valencia, Pepe. (2004). Inspired 3D short film production. Thomson. Book. [\[URL\]](#)
- Kerlow, Isaac V. (2009). The art of 3D computer animation and effects. John Wiley & Sons, 4th ed.. Book. [\[URL\]](#)
- Rodríguez Rodríguez, Alberto (2010). Proyectos de animación 3D. Anaya Multimedia. Book. [\[URL\]](#)
- Wissler, Virginia Bowman (2013). Illuminated Pixels : The Why, What, and How of Digital Lighting. Cengage Learning. Book. [\[URL\]](#)

## 7. Recommendations

Recommended subjects to have taken previously:

Modelaxe 1/616G02015

Recommended subjects to take simultaneously.

Animación 1/616G02018

Subjects that continue the content:

Técnicas Avanzadas de Render/616G02024

Shading/616G02027

Proyecto de Animación/616G02021

Postproducción 3D e Efectos Visuais/616G02022