Bachelor in Design and Development of Video Games

Titles, contents and timetable

Escuela Técnica Superior de Ingeniería Informática

Universidad Rey Juan Carlos

URJC · Escuela Técnica Superior de Ingeniería Informática

Contents

Prologue

This document contains information about titles, contents and timetable of subjects taught in the Bachelor in Design and Development of Video Games, offered at Rey Juan Carlos University, Escuela Técnica Superior de Ingeniería Informática. This information pretends to be helpful to international students interested in visiting our University.

Contents in this document referred to subjects taught during course 2021-2022. More information can be consulted in

https://www.urjc.es/estudios/grado/632-diseno-y-desarrollo-de-videojuegos.

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First Course

1.1 First Semester

1.1.1 Physics for Video games

The goal of this course is to provide students with the foundations of the two most important branches of physics for video games: electronics and mechanics. On electronics, the course includes the introduction to the representation of digital information, as well as the study of combinational and sequential circuits. On mechanics, the course includes understanding of kinematics, statics, dynamics, and their application to particles, rigid bodies and deformable bodies.

6 ECTS credits.

1.1.2 Discrete Mathematics

Linear Algebra. Matrices and systems of linear equations. Vector spaces. Linear and affine transformations. Determinants. Eigenvalues and Eigenvectors. Diagonalization. Discrete Mathematics.: Introduction to Logic. Introduction to Combinatorics. Graph Theory.

6 ECTS credits.

1.1.3 Visual Programming

Introduction to programming with Java. Control structures. Subprograms. Recursion. Data structure. Homogeneous data structure. Heterogeneous data structures and files

6 ECTS credits.

1.1.4 Narration, script and storyboard

The subject's objective is the analysis of the narrative elements of the video game, its relationship with fictional universes and other media such as film, as well as the techniques of creating a video game project from the idea to the storyboard, going

through the creation of the story, the characters, actions, rules, etc.

6 ECTS credits.

1.1.5   2D design

The course deals with the following contents: Introduction to visual culture analysis. Concepts of drawing, color and composition. Basic skills of digital two-dimensional design with software tools (Photoshop). Basic concepts of 2D animation and examples with Adobe Animate. Basic 2D game programming techniques with Action Script with Adobe Animate and Unity.

6 ECTS credits.

1.2   Second Semester

1.2.1   Data Structures

Introduction: Complexity of algorithms; Concepts of Java programming language. Linear data structures: Linear Lists; Stacks; Queues. Non-linear data structures: Sets; Binary trees; Graphs; Maps and hash tables.

6 ECTS credits.

1.2.2   Geometric models

Introduction to trigonometry, Vector space, Affine geometry, Projections and virtual camera models. Curves and surfaces, Differential Geometry.

6 ECTS credits.

1.2.3 Basic legal principles: professional ethics and equality

Basic legal principles. Introduction to Legal System. General Framework of Civil Law. General Framework of Commercial and Company Law. IT and ICT Law. Privacy and Data Protection. IT and ICT Law. Intellectual and industrial property rights. IT and ICT Law. Consumer and user protection. IT and ICT Law. The so-called cybercrimes or computer offences. Game designer & developer and computer engineering careers. Professional Codes of Practice and Ethical Conduct. Professional profiles. Licensing, business models and trends.

6 ECTS credits.

1.2.4 Multimedia

Fundamentals and characterization: Media. Human-computer interaction. Evaluation. Multimedia content development: Text and Typography. Image and Photography. Sound and Music. Video and Animation. Web development. Interactivity.

3 ECTS credits.

1.2.5 3D design

3D Modelling: 3D Modelling fundamentals. Representation of surfaces and volumes. Geometric editing techniques. Low polygon 3D modelling for video games. Inorganic modelling: Volume modelling with primitives and modifiers. Surface modelling. Composition objects. Mesh modelling Organic modelling: Box modelling (low-poly characters). Texturing, Lighting, Animation and Rendering Tools: Surface Texturing. Materials fundamentals. Materials. Mapping. Lighting and rendering techniques: Lighting fundamentals. Global GI lighting. Advanced materials and HDRI. Animation: Animation fundamentals. Basic elements of character animation: Rigging.

6 ECTS credits.

1.2.6   Game design and playability fundamentals

Video game structure: Video Game Design Concepts. Mechanics. Dynamics. Level design. Game Design Document. Design characteristics according to genres: Strategy. Adventure. Action. Simulation. Sports. RPG. Serious games.

3 ECTS credits.

2

Second Course

2.1 First Semester

2.1.1 Artistic Drawing

Fundamentals of Drawing. Materials and techniques of representation in drawing and paintin. Freehand drawing (quick notes, sketch, etc.) The portrait. Canon of the human figure. Volume and perspective of the human figure. Drawing of animals, plants and objects. Configuration and visual organization elements. Color, textures, shapes and lighting. Visual composition. Projection methods In Technical Drawing Art and creativity in video games. Concept art. Style creation. Character desing. Environments, tools and props desing. Storyboard.• Presentation of a concept art project. Visual analysis of a video game

3 ECTS credits.

2.1.2 Database Systems

In this subject, the fundamental concepts of the theory and practice of databases will be studied. It will focus on aspects like design and management of databases and information retrieval. Conceptual and logical data models (Entity / Relationship Model and Relational Model) will be studied and used. In addition, the SQL language will be taught, as a language for the definition, manipulation, and database query.

In brief, the contents are the following: principles and advantages of database systems; conceptual and logical design of databases; Entity / Relationship model; Relational model; conceptual design of data models and relational databases; SQL language principles; information storage using files; basic design and management of relational databases using CASE tools.

6 ECTS credits.

2.1.3 Advanced Programming

Object Oriented Programming with C++ to develop video games. There are three main parts: Essential of C for C++, OOP in C++, Advanced C++. A game engine is developed during the course.

6 ECTS credits.

2.1.4 Statistics

Descriptive Statistics. Description and representation of data. Bivariate data: correlation and regression. Probabilistic models. Probability Random variables. Statistical inference. Inference methods.

6 ECTS credits.

2.1.5 Fundamentals of video game technology

Object oriented programming. Fundamentals of Javascript. Events oriented programming. Sounds and Graphics in Javascript Animation and movement ni Javascript

3 ECTS credits.

2.1.6 Computer Graphics

Introduction to graphic pipeline (GPU, OpenGL). Introduction to global and local illumination algorithms.Introduction to OpenGL language. Introduction to shading language (GLSL). Use and implementation of textures in OpenGL. Implementation of basic illumination methods in OpenGL.Deferred Rendering and blending. Post processing techniques, including anti aliasing methods. Raytracing ang global illumination in real time.

6 ECTS credits.

2.2   Second Semester

2.2.1   Graphic Architectures

Introduction to computers: Von Neumann model. Functional units. Execution of instructions and programmes. Performance measures. Representation of information: Binary, octal and hexadecimal systems. Numerical representation in fixed point. Floating-point representation. Character representation and ASCII code. Assembler programming: Instruction repertoires and addressing modes. High-level and low-level low-level languages. Introduction to MIPS microprocessors. Operations with different types of data. Assembler control statements. Data structures. Subroutines. Introduction to digital systems: Boolean algebra. Combinational systems. Sequential systems. Arithmetic circuits: Arithmetic-logic unit. Floating-point operators. Data path and control: Modular construction of data paths. Operation of data paths. Introduction to the memory hierarchy: Main memory. Cache memory. Virtual memory. Introduction to input/output systems: Peripherals. Buses. I/O management. Instruction Level Parallelism: ILP concept. Concept of segmentation. Risks of segmentation. Data dependencies. Operation of the segmented data path. VLIW processors. Superscalar processors. Vector processors. Introduction to high-performance systems: Basic concepts of parallelism. Multicore systems. Distributed systems. Introduction to GPUs. Current trends.

6 ECTS credits.

2.2.2   Business and Video Games

The video game industry. Business models in video games. Video game companies. Video game business management and administration. Production, financial, and marketing management. Human resources management..

6 ECTS credits.

2.2.3 Introduction to Mathematical and Numerical Methods

One variable Calculus. Elementary Functions.•Continuity and Derivability of one variable functions. Solving nonlinear equations. Optimization. Integration of one variable functions. Computing areas. Numerical integration and Applications Multi variables Calculus. Limits and continuity of multi variables functions. Derivation of multi variables functions. Taylor's series and approximation. Optimization. 2D and 3D curves. Computing the length of a curve. Applications.

6 ECTS credits.

2.2.4 Video Game Development Process

In this subject you will learn an introduction to the development of Video Games. Methodologies and planning of software development and adaptation to the field of video games. Software teams and processes. Requirements engineering and evaluation of quality requirements in video games.

6 ECTS credits.

3

Third Course

3.1   First Semester

3.1.1   Video Game Engineering

Software engineering, Design Patterns, Virtual worlds, Scripting languages, Specific technologies for video games, Component integration.

3 ECTS credits.

3.1.2   Game Development with Artificial Intelligence

Artificial Intelligence in the video game industry, Search problems and agents. Uninformed search, Weak Heuristic Search, Strong Heuristic Search, Multiagent and Zero-Sum Search. Machine Learning problems, Q-Learning, N-gram prediction, Decision trees and other supervised techniques.

6 ECTS credits.

3.1.3   Advanced Graphics Processors

Introduction, graphics pipeline and GPUs. General purpose programming using GPUs (GPGPU). GPU computing. Global illumination. Ray Tracing from CPU to GPU

6 ECTS credits.

3.1.4   Network Games

Introduction to network games and communication networks. Development on the client side. Game development with web technology. Development on the server side. Communication with WebSockets.

6 ECTS credits.

3.1.5 Human-Machine Interaction and Usability

Human factors in human-computer interaction. User-friendly interface design methods: user-centred design and iterative design. Analysis, design and evaluation of interfaces. Help system design. Graphic design principles. Event-driven programming. Visual programming of graphical interfaces. Interfaces for video games. Types and uses of current input/output devices in video games. Video games evaluation. Video games and accessibility. Universal design including people with disabilities, the elderly, children or people with a temporary disability.

6 ECTS credits.

3.1.6 Audiovisual Language and Interactive Media

Bases of audiovisual and interactive language applied to creation of cut scenes. Audiovisual image. Audiovisual script. Iconic band and soundtrack. Aesthetic and visual foundations Key elements of audiovisual language. Time and space through audiovisual. Interrelations between cinema and video games.

3 ECTS credits.

3.2 Second Semester

3.2.1 Data Management in Digital Media

Introduction to Data Management. Semi-structured Information Storage. Non-Relational Information Storage. Storage of Unstructured Information. Security and Data Protection.

6 ECTS credits.

3.2.2 Algorithms for Computer Games

General concepts and introduction to recursion. Complexity analysis. Divide and Conquer algorithms. Greedy algorithms. Backtracking and Branch and Bound algorithms. Specific algorithms for computer games design.

6 ECTS credits.

3.2.3 Sound and Music for Video Games

Fundaments of sound and music. Music for audiovisual media. Introduction to sound in video games. Sound elements in video games. Fundaments of Digital Audio. Audio Editing Tools.

3 ECTS credits.

3.2.4 Characters and Scenarios

This subject covers the key concepts for the design and creation of characters and scenarios. Introduction. Artistic fundamentals: Composition. Light and colour. Visual narrative applied to video games. Design of environments: Basic principles and procedures in the design of scenarios. Presentation of projects. The digital portfolio. Character and Creature Design: Basic principles and procedures. The hero's journey Anatomy and use of shapes. Silhouettes. Proportions, from realism to cartoon. Character model sheet: poses, expressions, lip sync, colour. Use of 3D base for the design of characters. Costumes and accessories. The character's inventory. Scenario design. Basic principles and procedures. Perspective and depth. Tools and techniques. Change of season and lighting. Layout. Digital matte painting. Use of 3D base for scenery design. Playability applied to scenery design.

3 ECTS credits.

3.2.5 Multiplayer Environments

Introduction to concurrent and parallel programming. Message passing and shared memory models of concurrency. Games as distributed systems. History and evolution of multiplayer games. Technical considerations of multiplayer games. Game network architectures. Resources and constraints. Compensation techniques. Design guidelines. Cheating in online games. Authoritative servers. Netcode for Game Engine.

6 ECTS credits.

3.2.6 Virtual Reality

Introduction to Virtual Reality: basic concepts, applications and history. Perception: human perception, perception of virtual environments, presence and immersion, cybersickness, evaluation. Virtual reality devices: locomotion, tracking, 3D Audio, other devices. Stereoscopic vision: algorithms for stereoscopy, head mounted devices. Haptic interaction: haptic interaction in virtual reality, haptic rendering, haptic navigation. Architectures for virtual reality and study of examples.

6 ECTS credits.

3.2.7 3D Animation

The objective of this course is to understand the creative process of 3D scenes and characters, wtih a focus on their animation. Students will learn animation techniques, and they will integrate them into a game engine.

6 ECTS credits.

4

Fourth Course

4.1 First Semester

4.1.1 Visual Design and Final Art

Realization of a final art project of a video game. Concept, references and history.Game Design Document - Design development (Concept art 2D / Animation 3D). Use of creative techniques and types of graphics. Dissemination of a final art project of a video game. Cover, poster. Portfolio - Trailer, teaser, demo reel. Diffusion on the internet, web, networks, etc.

3 ECTS credits.

4.1.2 Character Behaviour

The course deals with the process of creating the autonomous agents of a video game. NPCs, or non-player characters are complex intelligent agents that must act according to a series of premises within a scenario. The students will study architecture and the process necessary to create a character and the artificial intelligence mechanisms that will allow it to interact with its environment and with the player.

3 ECTS credits.

4.1.3 Project Planning and Management

Fundamentals of project management, activity diagramas, Cost PERT diagrams, Gantt diagrams and project planning

6 ECTS credits.

4.1.4 Development of Applications for Mobile Devices

Introduction to mobile devices. User interfaces design. Persistent storage. Multimedia content management. Mobile games development.

6 ECTS credits.

4.1.5 Web Video Games and Social Networks

Web Video Games and Social Networks This course will extend the study of the subjects Multiplayer Environments and Network Games. It will deal with the development of games in web browsers that can be visualised in different engines, the development of games on the Internet, games in Social Networks. Aspects related to the virtual economy in these games and the different business models will also be dealt with.

6 ECTS credits.