# Course Syllabus

**UNIVERSITY OF MACAU**
**FACULTY OF SCIENCE AND TECHNOLOGY**
**DEPARTMENT OF COMPUTER AND INFORMATION SCIENCE**
**CISB459**
**SPECIAL TOPICS IN COMPUTER AND INFORMATION SCIENCE I & II**
**(VIRTUAL REALITY AND DIGITAL ENTERTAINMENT)**

**Syllabus**
**2nd Semester 2014/2015**
**Part A – Course Outline**

## Elective course in Computer Science

**Catalog description:**
(2-2) 3 credits. Virtual reality; multiple modal interaction, visual-auditory-haptic, interaction inmersion and imagination, visual computation and environmental modeling; geometric behavior and physically based simulation; management of large scale environment, VR development tools, augmented reality, mixed reality, digital entertainment.

**Course type:**
Theoretical with substantial laboratory/practice content

**Prerequisites:**
- CISB110(C/C++), CISB210(Data Structure), COIS712/ CISB355(CG)

**Textbook(s) and other required material:**
- Burdea, G. C. and P. Coffet. ***Virtual Reality Technology***, Second Edition. Wiley-IEEE Press, 2003/2006.

**References:**
1. Sherman, William R. and Alan B. Craig. Understanding Virtual Reality – Interface, Application, and Design, Morgan Kaufmann, 2002.
2. Fei GAO. Design and Development of Virtual Reality Application System, Tsinghua Press, March 2012.
（高飞．虚拟现实应用系统设计与开发，清华大学出版社，2012 年 3 月）.
3. Guangran LIU. Virtual Reality Technology, Tsinghua Press, Jan. 2011.
…(刘光然．虚拟现实技术，清华大学出版社，2011 年 1 月）.

**Major prerequisites by topic:**
- Fundamental calculus.
- Continuous and discrete mathematics.

**Course objectives:**
- To make students know the basic concept and framework of virtual reality. [a]
- To teach students the principles and multidisciplinary features of virtual reality. [a, j]
- To teach students the technology for multimodal user interaction and perception in VR, in particular the visual, audial and haptic interface and behavior. [a, j]
- To teach students the technology for managing large scale VR environment in real time. [a, j]
- To provide students with an introduction to the VR system framework and development tools. [a, j]

**Topics covered:**

- **Introduction of Virtual Reality(3 hours):** Fundamental Concept and Components of Virtual Reality. Primary Features and Present Development on Virtual Reality
- **Multiple Modals of Input and Output Interface in Virtual Reality(4 hours):** Input -- Tracker, Sensor, Digital Glove, Movement Capture, Video-based Input, 3D Menus & 3DScanner etc. Output -- Visual / Auditory / Haptic Devices
- **Visual Computation in Virtual Reality(4 hours):** Fundamentals of Computer Graphics. Software and Hardware Technology on Stereoscopic Display. Advanced Techniques in CG: Management of Large Scale Environments & Real Time Rendering
- **Environment Modeling in Virtual Reality(4 ours):** Geometric Modeling, Behavior Simulation, Physically Based Simulation
- **Interactive Techniques in Virtual Reality(2 hours):** Body Track, Hand Gesture, 3D Manus, Object Grasp
- **Introduction of Augmented Reality (AR)(3 hours):** System Structure of Augmented Reality. Key Technology in AR.
- **Development Tools and Frameworks in Virtual Reality(4 hours):** Frameworks of Software Development Tools in VR. X3D Standard; Vega, MultiGen, Virtools etc
- **Application of VR in Digital Entertainment (4 hours):** VR Technology in Film & TV Production.VR Technology in Physical Exercises and Games. Demonstration of Digital Entertainment by VR

**Class/laboratory schedule:**

| **Timetabled work in hours per week** | | | **No of teaching weeks** | **Total hours** | **Total credits** | **No/Duration of exam papers** |
|---|---|---|---|---|---|---|
| **Lecture** | **Tutorial** | **Practice** | | | | |
| 2 | 2 | Nil | 14 | 56 | 3 | 1 / 3 hours |

**Student study effort required:**

| | |
|---|---|
| **Class contact:** | |
| Lecture | 28 hours |
| Tutorial | 24 hours |
| In-class assignment / Hands-on practice | 4 hours |
| **Other study effort** | |
| Self-study | 32 hours |
| Homework assignment | 12 hours |
| **Total student study effort** | 100 hours |

**Student assessment:**

Final assessment will be determined on the basis of:

Homework & Quiz 20%
Mid-term 30%
Final exam 50%

**Course assessment:**

The assessment of course objectives will be determined on the basis of:

- Homework and exams
- Course evaluation

**Course outline:**

| **Weeks** | **Topic** | **Course work** |
|---|---|---|
| 1 | **Introduction to Virtual Reality**<br>Fundamental Concept and Components of Virtual Reality,<br>Primary Features and Present Development on Virtual Reality | |
| 2,3 | **Multiple Modals of Input and Output Interface in Virtual Reality** | |

| Weeks | Topic | Course work |
|---|---|---|
| | Input -- Tracker, Sensor, Digital Glove, Movement Capture, Video-based 3D Menus & 3DScanner etc; Output -- Visual / Auditory / Haptic Devices | |
| 4,5 | **Visual Computation in Virtual Reality (1)**<br>Fundamentals of Computer Graphics; Real time rendering technology; Principles of Stereoscopic Display; Software and Hardware Technology on Stereoscopic Display | Assignment#1 |
| 6,7 | **Environment Modeling in Virtual Reality**<br>Geometric Modeling; Behavior Simulation**;** Physically Based Simulation | Assignment#2 |
| 8 | **Mid-term review and mid-term exam.** | Mid-term exam |
| 9,10 | **Haptic & Force Interaction in Virtual Reality**<br>Concept of haptic interaction; Principles of touch feedback and force feedback; Typical structure and principles of touch/force feedback facilities in applications. | Assignment#3 |
| 11,12 | **Augmented Reality**<br>System Structure of Augmented Reality; Key Technology in AR; General solution for calculating geometric & illumination consistency in the augmented environment. | Assignment#4 |
| 13 | **VR Development Tools**<br>Frameworks of Software Development Tools in VR; Modeling Tools for VR; X3D Standard; Vega, MultiGen, Virtools etc | |
| 14 | **Review and Final Examination** | Final Exam |

**Contribution of course to meet the professional component:**
This course provides students the fundamental knowledge of virtual reality required for their professional career in this field, and applied to various applications such as digital entertainment.

**Relationship to CS program objectives and outcomes:**
This course primarily contributes to Computer Science program outcomes that develop student abilities to:
(a) An ability to apply knowledge of computing and mathematics to solve complex computing problems in computer science discipline.
(j) An ability to use current techniques, skills, and tools necessary for computing practice with an understanding of the limitations.

**Relationship to CS program criteria:**

| Criterion | DS | PF | AL | AR | OS | NC | PL | HC | GV | IS | IM | SP | SE | CN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Scale: 1 (highest) to 4 (lowest)** | | | 3 | | | | | 4 | 4 | | | | 2 | 2 |

Discrete Structures (DS), Programming Fundamentals (PF), Algorithms and Complexity (AL), Architecture and Organization (AR), Operating Systems (OS), Net-Centric Computing (NC), Programming Languages (PL), Human-Computer Interaction (HC), Graphics and Visual Computing (GV), Intelligent Systems (IS), Information Management (IM), Social and Professional Issues (SP), Software Engineering (SE), Computational Science (CN).

**Course content distribution:**

| Percentage content for | | | |
|---|---|---|---|
| Mathematics | Science and engineering subjects | Complementary electives | **Total** |
| 10% | 90% | 0% | 100% |