Subject Description Form

Subject Code	COMP448
Subject Title	Virtual Reality and Applications
Credit Value	3
Level	4
Pre-requisite / Co-requisite/ Exclusion	Pre-requisite: COMP407 Co-requisite: Nil Exclusion: COMP421, COMP438
Objectives	This subject will provide students with: ● skills for generating 3D VR worlds; ● animation techniques; ● visualization and rendering techniques; ● VR interfaces and devices; ● the principles of development for large VR worlds; ● dynamics and persistence of VR environments;. ● evolution and scalability of VR; ● VR applications: 3D games, movies and special effects, GIS, aerospace, medicine, science and engineering applications.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: *Professional/academic knowledge and skills* (a) solve problems in 3D modeling for VR worlds; (b) understand illumination and light transport techniques for VR rendering; (c) understand the major problems in time and space sampling of 3D graphics; (d) implement a scalable rendering system; (e) understand the characteristics of visualizing physical and non-physical data; (f) develop and maintenance of large VR environments; (g) understand Augmented Reality and its applications.

	Attributes for all-roundedness (h) gain a new perspective on physically-based simulations as well as information visualization; (i) design and develop high quality visual applications that are required in all aspects of digital communication, representation and dissemination of data for scientific, engineering, medical and financial analysis; VR models, development, scalability, interaction and social impact. **Alignment of Programme Outcomes:** Programme Outcome 1: This subject contributes to communicative effectively by having students practice programming in small groups in the lab and solving VR design in small teams. Programme Outcome 2: This subject contributes to the global outlook by having students understand the use of virtual reality and immersive technologies for different applications and their uses. Programme Outcome 4: This subject contributes to critical thinking through tutorial and lab exercises as well as direct exchanges on novel uses of 3D rendering and visualization algorithms. They will also practice in written assignments, programming exercises, and potential projects. Programme Outcome 5: This subject contributes to technical problem solving by initiating a wide variety of application design and implementation skills through lab exercise and mini-project with proper design and implementation. Programme Outcome 7: This subject contributes to team work by employing a small group-based approach to lab problem solving, assignments and mini-projects.
Subject Synopsis/ Indicative Syllabus	**Topic** 1. **High performance computer graphics hardware support** Computer graphics pipeline; image buffers; geometrical data streams; color management; programmable GPU; texture memory; display systems; image resolution; interactive control and event management. 2. **Object space and image space sampling** Device independent image representation; sampling; filtering; anti-aliasing techniques; object space discretization; surface sampling criteria; point-based representations; view mapping and projections; multi-phase object-space and image-space rendering. 3. **Shape modeling and representation** Point-based object representation; polygonal mesh representations; boundary surface representations and volumetric object and space partitioning; implicit and parametric shape representations; piece-wise continuous curves and surface patches; basis functions; subdivision schemes and scalability. 4. **Physical light and color** Achromatic light and intensity; illumination and dynamic range; physical

	light spectrum; colorimetry; color spaces and gamut mapping; color perception; advanced color models for VR rendering. **5. Scalable shape modeling and representation** Large data representation and scientific visualization; structural information; multidimensional projections; representation of time and space; virtual reality with applications in science and engineering; medical diagnosis; geographic information systems; data flows and relational diagrams. **Laboratory Experiment:** Laboratory exercises will normally be based on exercises and demonstration of the commonly available computer graphics API such as OpenGL. The students will be exposed to examples of shape modeling, rendering, animation and data visualization. **Case Study:** If applicable, case studies may be conducted on modeling and design systems that are used in commercial applications.
Teaching/Learning Methodology	The teaching methodology is based on these main activities: 1. Lecture delivery 2. Laboratory exercises consisting of hands-on exercises and tests 3. Tutorial sessions in and/or outside the lecture and laboratory sessions 4. Office hours questions, answers and clarification of material 5. Discussion sessions with optional additional workshops, lectures and labs The learning methodology will be based on: 1. Lecture notes 2. Laboratory notes and programming exercises 3. Textbook material 4. Additional reference material 5. Web links to active tutorials and other presentation material

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)								
		a	b	c	d	e	f	g	h	i
1. Assignments	30%	✓	✓	✓	✓	✓				
2. Lab exercises			✓	✓	✓	✓				
3. Project										
4. Mid-term	30%	✓	✓	✓						
5. Examination	40%	✓	✓	✓	✓	✓				
Total	100 %									

The assignment weights will be effectively distributed amongst the intended subject learning outcomes to nurture creative thinking, independence, teamwork, technical skills and a global perspective towards the technological base of this subject. Specifically, the assignments and the lab exercises are selected to develop the technical skills and knowledge to solve problems in computing and software development as well as to realize effective solutions, understand, evaluate and develop a critical perspective in the development of both small and large systems and integration of systems. Critical thinking, effective communication and a demonstrable global outlook will be incorporated at every level of exercises and mid-term examinations. The final examination accounts for a global and comprehensive understanding of the entire subject material and serves as the final checkpoint for the learning outcomes against technical skills and critical problem solving with respect to all components of virtual reality systems and 3D user interface design.

Student Study Effort Expected

Class contact:	
▪ Lecture	39 Hrs.
▪ Laboratory	0 Hrs.
Other student study effort:	
▪ Class participation	4 Hrs.
▪ Course work: reading, discussions, homework	52 Hrs.
Total student study effort	95 Hrs.

Reading List and References

Suggested Reference Books:

Alan Craig, William R. Sherman, Jeffrey D. Will, "Developing Virtual Reality Applications: Foundations of Effective Design," Morgan Kaufmann Publishers 2009.

G. Burdea and P. Coiffet, "Virtual Reality Technology," John Wiley and Sons, Second Edition, 2003.

S. Diehl, Distributed Virtual Worlds: Foundations and Implementation

	Techniques Using VRML, Java, and CROBA, Springer-Verlag, 2001. Alan Watt and Mark Watt, Advanced Animation and Rendering Techniques, Theory and Practice, Addison-Wesley, 1992. Hill, F.S. Jr., Computer Graphics Using Open GL, Second Edition, Prentice Hall, 2001. Watt, A. and Policarpo, F. The Computer Image, Addison-Wesley, 1998. Michael Mortenson, Mathematics for Computer Graphics Applications: An Introduction to the Mathematics and Geometry of CAD/CAM, Geometric Modeling, Scientific Visualization, and Other CG Applications, Industrial Press, 1999.