Computer Vision

1. **Course number and name:** 020CVNES4 Computer Vision

2. **Credits and contact hours:** 4 ECTS credits, 2x1:15 contact hours

3. **Name of course coordinator:** Chantal Hajjar

4. **Instructional materials:** Course handout, Powerpoint slides

   References:
   - Richard Szeliski, "Computer Vision: Algorithms and Applications".
   - by David Forsyth and Jean Ponce, "Computer Vision: A Modern Approach".
   - Rafael Gonzalez and Richard Wood, "Digital Image Processing".

5. **Specific course information**
   a. **Catalog description:**
   This course introduces students to the fundamental principles and practical techniques of computer vision. Topics include image filtering, feature extraction, edge detection, geometric transformations, object detection, segmentation, and 3D vision. Students will also explore modern deep learning-based approaches such as convolutional neural networks (CNNs), Vision Transformers (ViTs), object detection models (YOLO, SSD), and convolutional autoencoders (CAEs) for dimensionality reduction and denoising. Applications span image classification, depth estimation, and video analysis. Through hands-on labs and projects using Python and libraries like OpenCV, PyTorch, and Scikit-image, students will develop the skills to build, evaluate, and deploy computer vision systems.

   b. **Prerequisites:** 020THSES2/020STHES1 Signal Theory

   c. **Required** for CCE Artificial Intelligence Option students; **Selected Elective** for students in the CCE Software Engineering and Telecommunication Networks Options.

6. **Educational objective for the course**
   a. **Specific outcomes of instruction:**
   - Introduction to Computer Vision and Image Formation (1 lecture)
   - Image Filtering and Edge Detection (2 lectures)
   - Feature Detection and Matching (SIFT, ORB, Harris) (2 lectures)
   - Object Detection with Traditional Methods (e.g., HOG + SVM) (2 lectures)
   - Image Segmentation Techniques (Thresholding, Watershed, Graph Cuts) (2 lectures)
   - Introduction to Deep Learning for Vision (2 lectures)
   - CNN Architectures and Image Classification (2 lectures)
   - Vision Transformers: Theory and Applications in Vision Tasks (1 lecture)
   - Pretrained Models and Annotation Tools (1 lecture)

- Object Detection with Deep Learning (YOLO, SSD, Faster R-CNN) (3 lectures)
- Dimensionality Reduction using Autoencoders and CAEs (2 lectures)
- 3D Vision and Depth Estimation (1 lecture)
- Video Analysis: Optical Flow and Object Tracking (2 lectures).

b. PI addressed by the course:

PI	1.2	1.3	2.1	2.2	2.3	2.4	2.5	4.1	4.2	7.1	7.2
Covered	x	x	x	x	x	x	x	x	x	x	x
Assessed	x	x	x	x							

7. Brief list of topics to be covered

- Introduction to Computer Vision and Image Formation (1 lecture)
- Image Filtering and Edge Detection (2 lectures)
- Feature Detection and Matching (SIFT, ORB, Harris) (2 lectures)
- Object Detection with Traditional Methods (e.g., HOG + SVM) (2 lectures)
- Image Segmentation Techniques (Thresholding, Watershed, Graph Cuts) (2 lectures)
- Introduction to Deep Learning for Vision (2 lectures)
- CNN Architectures and Image Classification (2 lectures)
- Vision Transformers: Theory and Applications in Vision Tasks (2 lectures)
- Pretrained Models and Annotation Tools (1 lecture)
- Object Detection with Deep Learning (YOLO, SSD, Faster R-CNN) (2 lectures)
- Dimensionality Reduction using Autoencoders and CAEs (2 lectures)
- 3D Vision and Depth Estimation (1 lecture)
- Video Analysis: Optical Flow and Object Tracking (2 lectures)