1. **Course Number and Course Title:**
   ML 512 - Advanced Computer Vision

2. **Credits Hours:** 3 – 0 – 3

3. **Prerequisites and/or Co-Requisites:**
   Prerequisite: Approval of the CSE Head of Department Co-requisites: None
   Competencies: Undergraduate-level knowledge of linear algebra and programming

4. **Name and Contact Information of Instructor:**
   Name: Dr. Salam Dhou
   Email: sdhou@aus.edu
   Office: ESB-2179
   Phone: 05 515 2943
   Office Hours: Posted on office door and iLearn; also by appointment

5. **Course Description (Catalog Description):**
   Introduces the fundamental concepts and algorithms for computer vision. Covers key topics including camera model, multi-view geometry, image representation and filtering, visual perception and edge detection, and feature extraction. Examines advanced applications such as keypoint detection, object tracking, 3D reconstruction, image segmentation, face detection and recognition. Studies examples of computer vision applications using state-of-the-art software tools.

6. **Textbook and other Supplemental Material:**
   Textbook:
   - Szeliski, R., *Computer Vision: Algorithms and Applications*, Springer, 2nd ed., 2022.

   Supplemental material:
   - Forsyth D.A., Ponce J., *Computer Vision: A Modern Approach*, Pearson Education, 2nd ed., 2015.
   - Davies, E.R., *Computer Vision Principles, Algorithms, Applications, Learning*, Elsevier, 5th ed., 2017.
   - Computer vision software tools such as OpenCV, selected articles and journal papers.

7. **Course Learning Outcomes:**
   Upon completion of the course, students will be able to:
   1. Analyze the geometric representation and characteristics of projective transformations in 2D and 3D.
   2. Select and appraise different image representation and filtering techniques.
   3. Evaluate and compare several edge detection and feature extraction algorithms.
   4. Test and verify different keypoint detection and object tracking algorithms in real-world applications.
   5. Develop 3D reconstruction algorithms for different types of objects.

6. Compare different image segmentation techniques.
7. Develop face detection and recognition models.
8. Design and Implement computer vision techniques using state-of-the-art software tools.
9. Conduct research in the field of computer vision and its applications.

8. Teaching and Learning Methodologies:

Methods include lectures, problem and project-based learning methods (assignments, exams, research project, presentation), and class discussions.

9. Course Topics and Schedule:

Topic	Week
Introduction to Computer Vision, Camera Model and Calibration	Week 1
Multi-view Geometry: Geometric representations	Week 2
Multi-view Geometry: Characteristics of projective transformations in 2D	Week 3
Multi-view Geometry: Characteristics of projective transformations in 3D	Week 4
Image representation: Pyramids, Color, Texture	Week 5
Image processing: Filtering	Week 6
Visual perception and edge detection	Week 7
Feature extraction and image descriptors	Week 8
Midterm Exam	Week 9
Keypoint detection, object tracking	Week 10
3D reconstruction	Week 11
Image segmentation	Week 12
Face detection	Week 13
Face recognition	Week 14
Project Presentations	Week 15
Final Exam	Week 16

10. Schedule of Laboratory and other Non-Lecture Sessions:

The course has no laboratory. Homework assignments will be done in teams of two students each. The final project and report will be done in teams of three students. In final project, students are required to perform research, where they are expected to formulate a research problem, conduct literature review, perform modeling and simulations or conduct experiment, analyze results, submit a formal report and give an oral presentation.

In the final project and the report, each student will clearly indicate their level of involvement, effort, and contribution to the project or the report. All team members will be required to agree on these contributions. The grade of each individual student will be assessed based on quality of the overall project or report, and upon their respective contribution to the project or report.

11. Out-of-Class Assignments with Due Dates:

Homework Assignments	Due Date
Homework 1: Multiview geometry	Week 5
Homework 2: Image filtering and representations	Week 7

Homework 3: Feature extraction and image descriptors	Week 9
Homework 4: Keypoint detection and object tracking	Week 11
Homework 5: 3D reconstruction	Week 13
Research project and presentation	Week 15

12. Student Evaluation:

Assessment	Weight	Due Date
Homework	20%	Cf. Section 11
Research project and presentation	25%	Cf. Section 11
Midterm Exam	25%	Week 9
Final Exam	30%	Week 16

13. Assessment Instruments:

Assessment	Course Learning Outcomes
Homework	O1– O8
Research project and presentation	O1 – O9
Midterm Exam	O1– O3
Final Exam	O1 – O7

14. Contribution of Course to Program Outcomes:

MSML Program Outcomes	Emphasis in this course	Course Learning Outcomes
1. Perform research emphasizing creativity, independent learning, and scientific methods in the field of Machine Learning.	◑	O1 – O9
2. Apply advanced mathematics, computer science knowledge, and software tools in identifying, formulating, and solving real world problems.	●	O1 – O8
3. Demonstrate an in-depth understanding of modern Machine Learning approaches, algorithms, and tools.	○	O6, O7
4. Select and use techniques, skills, and modern tools necessary for research or professional practice.	◑	O2, O5–O9
5. Communicate effectively through technical presentations and reports.	○	O8, O9
6. Recognize the need for, and engage in, lifelong learning in professional areas.		
7. Attend to professional and ethical responsibilities within global and societal contexts.	○	O7 - O9

Emphasis: ● High; ◑ Medium; ○ Low; Blank – Nothing Specific Expected

15. Letter Grade Policy:

Total (T)	Letter Grade
$90 \leq T$	A
$85 \leq T < 90$	A-
$80 \leq T < 85$	B+
$75 \leq T < 80$	B
$70 \leq T < 75$	B-
$65 \leq T < 70$	C+
$60 \leq T < 65$	C

T < 60	F