

DeCAIR Course Syllabus Form

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Activity Number & Title	Activity 2.2: Designing and developing syllabi and content for the agreed upon courses in the new programs		
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Revision History

Version	Date	Author	Description	Action *	Page(s)
1	1/11/2021	Iyad Jafar	Computer Vision syllabus drafted	C	1-6
2	8/12/2021	Iyad Jafar	Revised based on 27/11/2021 meeting	U	1-6
3					
4					

(*) Action: C = Creation, I = Insert, U = Update, R = Replace, D = Delete

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Course title	Computer Vision																
Course number	0917549																
Credit hours (lecture and lab)	3 (3+0)																
ECTS (weekly contact and self-study load)	6 (3+3)																
Prerequisites/co-requisites by course number and name	AI and Machine Learning (0917451)																
Prerequisites by topic (other than the formal prerequisites above)	Students are assumed to have good background in mathematics, particularly, calculus, linear algebra, statistics, probability, good background in machine learning and Python/MATLAB programming skills																
Level and type (compulsory, elective)	Bachelor's elective course																
Year of study and semester	Fifth year, first or second semesters																
Catalogue description	Introduction to computer vision including fundamentals of computer vision at the low, medium and high levels. Topics include image formation, camera imaging geometry, feature detection and matching, stereo, motion estimation and tracking, video processing, deep-learning algorithms for image classification, object recognition, object detection and scene understanding. The course focuses on the practical aspects and implementation of these topics through homework assignments and term project.																
Objectives	<ol style="list-style-type: none"> 1. Introduce students to the computer vision concepts at different levels. 2. Introduce students to the practical techniques and tools used in computer vision (Python, Scikit-Learn, Keras, TensorFlow, and Opencv). 3. Enable the students to gain practical skills in computer vision problems. 																
Intended learning outcomes	Upon successful completion of this course, students will be able to: <table border="1" data-bbox="488 1480 1489 1883"> <thead> <tr> <th>No</th> <th>Intended learning Outcome (ILO)</th> <th>Program learning outcome (PLO)*</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Demonstrate a sound understanding of the main topics in computer vision.</td> <td>1</td> </tr> <tr> <td>2</td> <td>Solve real world problems in the computer vision domain.</td> <td>1, 2</td> </tr> <tr> <td>3</td> <td>Communicate the development of a solution for a computer vision problem through a detailed technical report.</td> <td>3</td> </tr> <tr> <td>4</td> <td>Use appropriate and common tools and libraries to solve real-world problems in computer vision.</td> <td>6, 7</td> </tr> </tbody> </table> (*) The PLOs are listed in the appendix		No	Intended learning Outcome (ILO)	Program learning outcome (PLO)*	1	Demonstrate a sound understanding of the main topics in computer vision.	1	2	Solve real world problems in the computer vision domain.	1, 2	3	Communicate the development of a solution for a computer vision problem through a detailed technical report.	3	4	Use appropriate and common tools and libraries to solve real-world problems in computer vision.	6, 7
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Teaching and learning methods	<p>Development of ILOs is promoted through the following teaching and learning methods:</p> <ul style="list-style-type: none"> • The student attends the class presentations and participates in the discussions. • The student joins the related online team/group and participates in its discussions. • The student studies the reference material, including books and videos. • The student solves the programming assignments in computer vision domain. • The student carries out a term project for solving a problem in the computer vision domain. • The student develops a professional report for the term report. • The student presents the term project in class. • The AI lab is open for the students to practice the practical aspects and solve the programming homework assignments.
Learning material type	<p>Textbook, class handouts, some instructor keynotes, selected YouTube videos, and access to a personal computer and the internet.</p>
Resources and references	<p>A- Required book(s), assigned reading and audio-visuals:</p> <ol style="list-style-type: none"> 1. Richard Szeliski, <i>Computer Vision: Algorithms and Applications</i>, 2nd Edition, Springer, 2021. 2. Jan Erik Solem, <i>Programming Computer Vision with Python</i>, O'Reilly Media, 2012. 3. M. Elgendy, <i>Deep Learning for Vision Systems</i>, 1st Edition, Manning, 2020. 4. S. Khan et. al., <i>A Guide to Convolutional Neural Networks for Computer Vision</i>, Morgan & Claypool, 2018. <p>B- Recommended book(s), material and media:</p> <ol style="list-style-type: none"> 5. D. Forsyth and J. Ponce Andries, <i>Computer Vision: A Modern Approach</i>, 22nd Edition, .Pearson India, 2011 6. François Chollet, <i>Deep Learning with Python</i>, Manning Pub. 2018. 7. Aurélien Géron, <i>Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow: Concepts: Tools, and Techniques to Build Intelligent Systems</i>, 2nd Edition, O'Reilly Media, Oct 2019.

Topic outline and schedule	Week	Topic	ILO	Resources
	1	Introduction		1
2-3	Image formation (Geometric primitives and transformations, Photometric image formation, The digital camera)		1,4	1,2
3-4	Image processing (Point Operators, Linear Filtering, Non-linear Filtering, Geometric Transformations)		1,4	1,2
5-6	Feature Detection and Matching (Points and Patches, Edges and Contours, Contour Tracking, Lines and Vanishing Points, Segmentation)		1,4	1,2
7	Motion Estimation (Translational Alignment, Parametric Motion, Optical Flow, Layered Motion)		1,2,4	1,2
8	Structure from Motion (Geometric intrinsic calibration, Pose estimation, Two-frame structure from motion, Multi-frame structure from motion, Simultaneous Localization and Mapping)		1,2,4	1,2
9	Depth Estimation (Epipolar geometry, Sparse correspondence, Dense correspondence, Local methods, Global optimization, Monocular depth estimation, Multi-view stereo)		1,2,4	1,2
	3D Reconstruction (Shape from X, 3D Scanning, Point-based Representation, Volumetric representation, Model-Based reconstruction, recovering texture maps and albedos)		1,2,4	1,2
10	Deep Learning - Review		1,2,4	1-4, 7
10-14	Recognition (Instance recognition, Image classification, Object detection, Semantic segmentation, Video understanding, Vision and language)		1,2,4	1-4, 7
15	Project Presentations		2,3,4	1-4, 7
Evaluation tools	Opportunities to demonstrate achievement of the ILOs are provided through the following assessment tools:			
	Assessment tool	Mark	Topic(s)	Time
	Homework assignments	10%	Programming aspects	W2-W14
	Midterm exam	30%	Introduction through SLAM	W8
	Term project report	10%	Practical and communication aspects	W15

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	Final exam	50%	All material	W16
	Total	100%		
Student requirements	The student should have a computer and internet connection.			
Course policies	<p>A- Attendance policies:</p> <ul style="list-style-type: none"> Attendance is required. Class attendance will be taken every class and the university polices will be enforced in this regard. <p>B- Absences from exams and not submitting assignments on time:</p> <ul style="list-style-type: none"> A makeup exam can be arranged for students with acceptable absence causes. Assignments submitted late, but before announcing or discussing the solution can be accepted with 25% penalty. The project report must be handed in in time. <p>C- Health and safety procedures:</p> <ul style="list-style-type: none"> All health and safety procedures of the university and the school should be followed. <p>D- Honesty policy regarding cheating, plagiarism, misbehavior:</p> <ul style="list-style-type: none"> Open-book exams All submitted work must be of the submitting student. Other text or code must be properly quoted with clear source specification. Cheating will not be tolerated. <p>E- Available university services that support achievement in the course:</p> <ul style="list-style-type: none"> Microsoft Teams team and Moodle course page AI Lab for practicing the practical aspects and solving the programming assignments. Program announcements Facebook group 			
Additional information	None			

Appendix

Learning Outcomes for the BSc in Computer Engineering

Students who successfully complete the BSc in Computer Engineering will be have:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.