UNIVERSITY REGISTRAR
VIRGINIA TECH

CM-6932 APPROVED
GCC: 10.14.21
CGPSP: 10.20.21

ENTERED
11.16.21 ~BS

Coversheet - Proposal for New and Revised Courses

(Use for non-Pathways courses)

For CLE/Pathways courses, form can be found here: https://www.pathways.prov.vt.edu/proposal-forms.html

General Information					
Proposal Date:	June 9, 2021	*Department:*	Mechanical Engineering		
Course Designator and Number (Cross-listed Course Designator and Number):	ME 5824 (CS 5844)				
Title of Course:	Algorithmic Human-Robot Interaction			*Credit Hours:*	3
Course Transcript (ADP) Title (30 Characters & Spaces Maximum):	Human-Robot Interaction				
Instructor and/or Departmental Contact:	Dylan Losey				
Contact Phone:	254-315-5512	*Contact E-mail:*	losey@vt.edu		
Please refer to Office of University Registrar for guidelines and policy requirements: https://registrar.vt.edu/governance.html					

Please count this course toward the following Scorecard Metrics areas:

☐ Study Abroad ☐ Service Learning ☐ Experiential ☐ Undergraduate Research

Scorecard Metrics Definitions can be found here: https://registrar.vt.edu/faculty-toolbox/scorecard-metrics.html

Please insert an X if this course should count toward First Year Experience:

☐ First Year Experience (FYE) *Include approval letter from FYE Director. More information can be found here:* http://www.fye.vt.edu

Select **ONE** of the following boxes		
X	New Course	☐ *Revised Course (Revision > 20% _____ Revision < 20% _____)*

*For **CLE/Pathways** courses, form can be found here*: https://www.pathways.prov.vt.edu/proposal-forms.html

Please include a summary of course revisions to the Justification section of proposal

A:	***Attach statement from Dean or Departmental Representative*** as to whether teaching this course will require or generate the need for additional departmental resources.			
B:	***Attach appropriate letters of support*** (e.g., prerequisite, corequisite, or cross-list memo) from affected departments and/or colleges.			
C:	***Effective Semester:***	Spring 2022		
D:	***Change in Title From:***			
	To:			
E:	***Change in Transcript Title (ADP) From:***		***To:***	
F:	***Change in Credit Hours From:***		***To:***	
G:	***Change in Lecture and/or Lab Hours From:***		***To:***	
H:	***Course Number(s) and Title(s) to be deleted from the Catalog with APPROVAL:***			

Approval Signatures			
Department Representative	Dr. Azim Eskandarian	*Date*	7/08/2021
College Curriculum Committee Rep		*Date*	7/13/21
College Dean or Designee		*Date*	7/13/21

Date: July 8th, 2021

To: University Registrar
Cc: Gary Costello, Associate Registrar & Becki Smith, Governance Coordinator

Re: Cross-Listing of ME 5824 (CS 5844)

The Department of Mechanical Engineering would like to request the ME 5824 (CS 5844), Algorithmic Human-Robot Interaction, course cross-listing effective Spring 2022.

It is understood that when this cross-listed course is scheduled (face-to-face or virtually) that a section of each course will be scheduled and taught in the same classroom or virtually, at the same time, and by the same faculty.

It is also understood that if the ME 5824 course is inactivated that the Computer Science Department must submit a new course proposal through the academic governance system if they wish to continue teaching the course offering.

ME 5824 (Mechanical Engineering) Dr. Azim Eskandarian

_____7/08/2021__
College Dean, Department Head, or Designee Date

CS 5844 (Computer Science) Dr. Cliff Shaffer

7/8/2021
_____
College Dean, Department Head, or Designee Date

Course Information

Catalog Description

Formalizing interaction between robots and humans. Developing learning and control algorithms that enable robots to seamlessly and intelligently collaborate with humans. Mathematical approaches to human-robot interaction, learning from demonstration, Bayesian inference, intent detection, safe and optimal control, assistive autonomy, and user study design. Students review and present existing literature, conduct a research project. Pre: Graduate Standing (3H, 3C).

Learning Objectives

Having successfully completed this course, the student will be able to:

1. Articulate the challenges of developing algorithms that support human-robot interaction.
2. Appraise and implement different methods that robots use to learn from human demonstrations.
3. Use Bayesian inference to detect human intent and autonomously assist humans.
4. Apply safe and optimal controllers so that the robots can safely but efficiently operate around humans.
5. Combine human and robot control inputs for assistive autonomy tasks.
6. Plan, conduct, and analyze a user study that involves human-robot interaction.
7. Assess the scientific merits and weaknesses of human-robot interaction research published in scholarly journals.
8. Carry out a research project that involves human-robot interaction and applies course concepts.
9. Communicate scientific content and research to a peer audience.

Justification

Human-robot interaction is a fundamental aspect of robotics. Virginia Tech currently offers a variety of courses on robot design, kinematics, and control. But employers often seek to develop robots for homes, offices, schools, hospitals, and roads. These employers need professionals with specific knowledge on how robots can seamlessly and intelligently collaborate with humans. Analogous courses on human-robot interaction are currently offered at peer institutions. For example, at the University of California, Berkeley, “Algorithmic Foundations of Human-Robot Interaction” was most recently offered in Spring 2021, and at Stanford University, “Safe and Interactive Robotics” was most recently offered in Fall 2019. Other related instances can be found at Carnegie Mellon University, University of Washington, and Georgia Tech. Finally, the topics offered in this course are not currently available at Virginia Tech. These new topics include how intelligent systems i) learn from humans, ii) make optimal decisions based on what they have learned, and iii) collaborate safely alongside humans.

This course is taught at the 5000 level because it builds on undergraduate training in robotics, control, and artificial intelligence while introducing advanced theoretical content. The skills acquired in this course will enable students to better critique and contribute to scientific publications within the field of human-robot interaction. Students will also gain the skills needed to develop systems for human-machine interaction in their graduate-level research and professional careers.

Prerequisites and Corequisites

Pre: Graduate Standing

Texts and Special Teaching Aids

Required Text:

None. There is no single text that covers all relevant topics for this course. The background material for this course will be provided by the instructor.

Recommended Texts:

Russell, S. & Norvig, P. (2020). *Artificial Intelligence: A Modern Approach*. Prentice Hall. pp. 412.

Thomaz, A., Hoffman, G. & Cakmak, M. (2016). *Computational Human-Robot Interaction.* Foundations and Trends in Robotics. pp. 134.

Topic Syllabus

Topic	Percent of Course
Human-robot interaction foundations & mathematical tools for formulating human-robot interaction	10
Learning from demonstration, specifically focusing on imitation and inverse reinforcement learning	20
Bayesian inference and mathematical models for predicting human behavior	10
Human intent detection during interactive tasks	10
Safe and optimal control for human-robot interaction	20
Assistive and shared autonomy that synthesizes human and robot inputs	10
User study design and statistical analysis of the results	10
Review and presentation of relevant scientific literature	10
	Total: 100%

Old (Current) Topic Syllabus

N/A

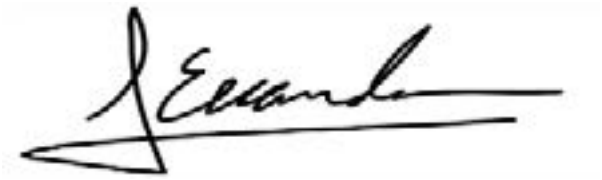
COLLEGE OF ENGINEERING
MECHANICAL ENGINEERING
VIRGINIA TECH

Department of Mechanical Engineering
445 Goodwin Hall (0238)
635 Prices Fork Road
Blacksburg, Virginia 24061
540/231-7183 Fax: 540/231-0422

Dear COE Curriculum Committee,

The Department of Mechanical Engineering is submitting a new graduate course proposal for **ME 5824 Algorithmic Human-Robot Interaction** course for your approval. The proposed course will serve as an elective for our graduate program and will not require any additional funding or resources from the College or University.

Sincerely,



Azim Eskandarian, D.Sc., ASME Fellow
Department Head
Nicholas and Rebecca Des Champs Chaired Professor
Mechanical Engineering Department
Virginia Tech