Indian Institute of Technology Kanpur

Proposal for a New Course - Elective

1. **Course No:**

2. **Course Title:** Design for Human Machine Systemic Relationships

3. Per week Lectures: **3**(L), Tutorial: **0** (T), Laboratory: **0** (P), Additional Hours [0-2]: **0** (A), Credits (3*L+2*T+P+A): **9** Duration of Course: **Full Semester**

4. **Proposing Department/IDP: Department of Design**
   Other Departments/IDPs which may be interested in the proposed course: Computer Science, Medical School, Mechanical Engineering, Industrial Engineering and other associated departments involved in HMI research, human factors research or broader research with human interaction with technology.

   Other faculty members interested in teaching the proposed course: none

5. **Proposing Instructor(s):** Vivek Kant

6. **Course Description:**

The aim of the course is help students design interactions with technologies in systems. The course is envisioned as a course on design for postgraduate students. It will also support dual degree students in design as well as students from other departments. The course will addresses the design of human technology relationships in systems. The current course is primarily a *design course* which is builds on human-centered design theory, human factors engineering and systems thinking. It does not address the design of the underlying technology or computation or addresses technology and human culture (Other courses on HCI in computer science, Informatics or humanities and sociology will be a better fit). This course will, nevertheless, supplement these other technological courses in providing the students a holistic understanding of human technology relationships by developing the design dimension of human technology relationships. In this course, the students will learn the basics of a design process for advanced human machine interaction/human automation interaction. They will be exposed to existing tools, techniques as well as the theoretical basis of design. The course is an appropriate mix of lectures and studio practice. The students will complete certain assignments individually as well as work on a mini-project as a team. The focus will be to use these ideas to develop interfaces in application areas related to social innovation, defence, industry 4.0, healthcare, finance, energy, AI, safety and security, amongst other areas.

a. **Course Objectives:**

At the end of this course, students will be able to,

- Understand and use the design process to design interfaces/interactions
- Use metrics and scales for evaluating interfaces/interactions
- Understand theory, methods and challenges associated with function allocation, situation awareness and other associated concepts in interaction design for complex systems

b. Course Content:

90 mins per session: 17 lecture sessions + 10 studio sessions

S.No.	Topic and Details	Sessions (Lectures & Studio)
1	**Foundations of Human-centered Interaction I** - Design and Cognition - Embodied, Embedded, Extended and Enactive Cognition - Activity Theory - Distributed Cognition - Elements of Operator experience	1
2	**Foundations of Human-centered Interaction II** - Human-centered Complexity - Human Technology relationships - Design for Human Behavior and Cognition in Complex systems - HMI & HCI - Designing for systemic roles	1
3	**Fundamentals of the Design Process** - Elements of the design process - High-performance HMIs - Ecological Interface Design (EID) - EID vs. user-centered design - Design Theory for HMIs - Digitalization and Human-Centered Design	2
4	Studio Practice 1: Problem formulation, Scoping based on Human-centered dimension of design	1
5	**Field Studies & Scenarios** - Interpretive basis of understanding - Creating a field study plan - Conducting a field study - Mapping Insights - Creating Scenarios	2

6	Studio Practice 2: Scenario Creation and Validation	1
7	**Analysis techniques** - Cognitive Work Analysis - Functional Abstraction - Structural Decomposition - Activity Analysis - Cognitive Task Analysis - Hierarchical Task Analysis - Other analysis techniques	3
8	Studio Practice 3,4: Task/Work Analysis process practice	2
9	**Functional Allocation** - Fitt's function allocation techniques - Human in the loop - Human automation interaction - Manned and unmanned systems - Teleoperation	2
10	Studio Practice 5: Function Allocation based analysis for the project	1
11	**Design for Situation Awareness** - Situation-awareness - Enemies of Situation Awareness (Fatigue, Data Overload, Salience…) - Situation-awareness oriented design - situation awareness and user-centered design	2
12	Studio Practice 6: Situation Awareness mapping and analysis	1
13	**Synthesis Techniques I** - Developing Information architecture - Part-whole relationships - Part-whole hierarchies for developing information architecture - Card-sorting methods	2
14	Studio Practice 7: Information architecture design	1
15	**Synthesis Techniques II** - Information Design - Navigation Design - Visual Design - Displays and controls - Visual ergonomics considerations	1

	- Physical ergonomics considerations	
16	Studio Practice 8,9: Prototype	2
17	**Evaluation of the interface/interaction** - Verification and Validation - Evaluation scales - Systems Usability Scale - Cognitive engineering heuristics	1
18	Studio Practice 10: Evaluation and user testing	1
	Total Sessions (Lectures + Studio)	27 sessions
	Total Hours = 27 * 1.5 hrs	40.5 Hrs

Assignments (studio+ term paper presentation) 60% + final exam 40 %

c. Pre-requisites, if any: None

d. Short Summary:

The aim of the course is to help the students design interactive experiences in systems using a human-centered design approach

e. Recommended Books:

Text book:

- Bennett, K. B., & Flach, J. M. (2011). *Display and interface design: Subtle science, exact art*. CRC Press.
- Endsley, M. R., Bolte, B., & Jones, D. G. (2003). *Designing for situation awareness: An approach to user-centered design*. CRC press.
- Vicente, K. J. (1999). *Cognitive work analysis: Toward safe, productive, and healthy computer-based work*. CRC press.
- Burns, C. M., & Hajdukiewicz, J. (2004). *Ecological interface design*. CRC Press.

References:

- Remington, Roger & Boehm-Davis, Deborah & Folk, Charles. (2012). Introduction to Humans in Engineered Systems. Hoboken, NJ, US: John Wiley & Sons, Inc.
- Sheridan, T. B. (1992). *Telerobotics, automation, and human supervisory control*. MIT press.
- Sheridan, T. B. (2002). *Humans and automation: System design and research issues*. MIT press.
- Booher, H. R. (2003). *Handbook of human systems integration*. John Wiley & Sons.
- Boy, G. A. (2020). *Human–systems integration: from virtual to tangible*. CRC Press.

- Jenkins, D. P., Stanton, N. A., Salmon, P. M., & Walker, G. H. (2017). *Cognitive work analysis: coping with complexity*. CRC Press.
- Hollnagel, E., & Woods, D. D. (2005). *Joint cognitive systems: Foundations of cognitive systems engineering*. CRC press.
- Woods, D. D., & Hollnagel, E. (2006). *Joint cognitive systems: Patterns in cognitive systems engineering*. CRC Press.
- Leveson, N. G. (2016). Engineering a safer world: Systems thinking applied to safety. The MIT Press.
- Casey, S. M. (1998). Set phasers on stun. Santa Barbara, CA: Aegean.
- Casey, S. M. (2006). The atomic chef: And other true tales of design, technology, and human error. CA: Aegean.
- Hollifield, B. R., Oliver, D., Nimmo, I., & Habibi, E. (2008). *The high performance HMI handbook: A comprehensive guide to designing, implementing and maintaining effective HMIs for industrial plant operations*. Houston: Pas.
- Boy, G. A. (Ed.). (2017). *The handbook of human-machine interaction: a human-centered design approach*. CRC Press.
- Journal Papers from the disciplines of Interface Design, Complex Systems, Sociotechnical systems and Human Machine Interaction

Dated: 8 May 2023 Proposers: Vivek Kant

Dated: DPGC Convener: