**Government of Russian Federation**

**Federal State Autonomous Educational Institution of High Professional Education**

**«National Research University Higher School of Economics»**

National Research University
High School of Economics
Faculty of Computer Science

# Syllabus for the course
# «Ergonomics of Human–Machine Interaction»

for Bachelor degree specialization
09.03.04 «Software Engineering»

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Approved by:

Recommended by:

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## 1. Teachers

**Instructor and author:** Alexey A. Klimov, National Research University Higher School of Economics, Faculty of Social Science, Department of Psychology.

## 2. Scope of Use

The present program establishes minimum demands of students' knowledge and skills, and determines content of the course.
The present syllabus is aimed at department teaching the course, their teaching assistants, and students of the course.

This syllabus meets the standards required by:

- Educational standards of National Research University Higher School of Economics;
- Educational program of Federal Bachelor's Degree Program for 2015;
- University curriculum of the Bachelor's program in 09.03.04 «Software Engineering» for 2016.

**Summary**

The course trains the computer science students what is a human factor, and how to make user-centered design and sustain proper fit in human-machine interaction. Introduction to the course is various design implementations besides graphical interfaces challenged in historical perspective. The first part of the course is limitless of humans. The second part of the course is science perspective to usability engineering or simply, design. Design rules are discussed including Standards, Guidelines, Rules-of-Thumb. Design process rationale, models and theoretical aspects are followed by couple of tools including prototyping and task analysis implementation.
Finally, interface quality and it evaluation methods through cognitive modeling, expert analysis, user participation is covered. Slightly covered accessibility topic.

## 3. Learning Objectives

The learning objective of the course «Ergonomics of Human–Machine Interaction» is to provide students with essential knowledge of Ergonomics applicable to design a real world object, with more narrow but today's most popular case of human-machine interaction called graphical interface.

## 4. Learning outcomes

After completing the study of the discipline «Ergonomics of Human–Machine Interaction» the student should:

- Know basic notation and terminology used in Ergonomics science and human factor
- Understand basic principles behind design rules (including Standards, Guidelines, Rules-of-Thumb)
- Be able to visualize, summarize and compare pros- and cons- of several design variants
- Be capable to evaluate interface quality through cognitive modeling, expert analysis and user participation

## 5. Prerequisites

The material that is both discussed in the course and recommended for self-studying presupposes the basic knowledge of visual design, statistics and computer science. A basic knowledge about R programing language will be an advantage.
Besides, students should be able to read and understand recommended papers (book chapters), accompanying materials and various online sources in English (mainly) as well as to prepare presentations on the work (research) done during mastering the course. Besides, brief presentations (*short oral report* on selected topics during the course) will have positive impact on the final grade.

The following knowledge and competence are needed to study the discipline:

- A good knowledge of the English language, both orally and written.
- A basic knowledge of mathematics or general statistics
- A basic programming experience

After completing the study of the discipline «Ergonomics of Human–Machine Interaction» the student should have the following competences:

| **Competence** | **Code (HSE UC)** | **Descriptors (indicators of achievement of the result)** | **Educative forms and methods aimed at generation and development of the competence** |
|---|---|---|---|
| The ability to think critically and interpret experiences (own and others') reflex social and professional activity. | СК-Б10 | The student is able to reflect visual design | Lectures and tutorials. |
| The ability to create program interface | ПК-14, ИК-14 | The student is able to visualize and summarize user-data, develop mockup. | Examples covered during the lectures and tutorials. Assignments. |
| The ability to describe problems and situations of professional activity in terms of humanitarian, economic and social sciences to solve problems which occur across sciences, in allied professional fields. | IC-M5.3_5.4_5.6_2.4.1 | The student is able to describe design in terms of Ergonomics and Human Factor science. | Lectures and tutorials. |

## 6. Schedule

Two pairs consist of 2 academic hours for lecture followed by 2 academic hours for computer exercises/labs after lecture. Additional office hours for lectures' content are provided.

| № | Topic | Total hours | Contact hours | | Self-study |
|---|---|---|---|---|---|
| | | | Lectures | Seminars | |
| 1. | Introduction to Ergonomics | 10 | 2 | 2 | 6 |
| 2. | Defining the machine | 10 | 2 | 2 | 6 |
| 3. | Human information processing | 11 | 2 | 2 | 7 |
| 4. | Human memory | 11 | 2 | 2 | 7 |
| 5. | Usability engineering or design | 11 | 2 | 2 | 7 |
| 6. | Design rules | 13 | 2 | 4 | 7 |
| 7. | Design process rationale | 11 | 2 | 2 | 7 |
| 8. | Human-Computer Interface | 13 | 2 | 4 | 7 |
| 9. | Overview of methods of design evaluation tools | 11 | 2 | 2 | 7 |
| 10. | Basic Experiment Designs | 11 | 2 | 2 | 7 |
| 11. | Analysis Experimental Design | 14 | 2 | 4 | 8 |
| 12. | Analysis Experimental Data | 16 | 2 | 6 | 8 |
| 13. | Gather user needs | 11 | 2 | 2 | 7 |
| 14. | Study of User Preferences by asking right questions | 11 | 2 | 2 | 7 |
| 15. | Review and final project (homework) description | 16 | 2 | 4 | 10 |
| **Total:** | | **180** | **30** | **42** | **108** |

**Requirements and Grading**

| **Type of grading** | **Type of work** | | |
|---|---|---|---|
| | Homework | 1 | Solving homework task and examples. |
| | Exam | 1 | Written exam. Preparation time – 120 min. |
| Final | | | |

## 9. Assessment

*The assessment* consists of one homework, handed out to the students during the semester. The homework required problems are based on each lecture topics.

*Final assessment* is the final exam. Students have to demonstrate knowledge of probability and statistics theory.

**The grade formula:**

***The exam*** will consist of 15 questions, giving ten marks each, worth 40% of the final mark.

***Final course mark*** *is obtained from the following formula*: Final=0,2*(Lecture & seminar attendance)+0.4*(Homework)+0.4*(Exam).

The grades are rounded in favour of examiner/lecturer with respect to regularity of class and home works. All grades, having a fractional part greater than 0.5, are rounded up.

**Table of Grade Accordance**

| **Ten-point Grading Scale** | **Five-point Grading Scale** | |
|---|---|---|
| 1 - very bad<br>2 – bad<br>3 – no pass | Unsatisfactory - 2 | **FAIL** |
| 4 – pass<br>5 – highly pass | Satisfactory – 3 | **PASS** |
| 6 – good<br>7 – very good | Good – 4 | |
| 8 – almost excellent<br>9 – excellent<br>10 – perfect | Excellent – 5 | |

## 10. Course Description

The following list describes the topics that will be covered in the course in correspondence with lecture order.

**Topic 1. Introduction to Ergonomics**
Objectives of the course. History and intellectual roots of human oriented paradigm. Interaction as communication.

**Supplementary materials:**
Video: Human Factors Success Stories 1987

**Supplementary readings:**
Human factors specialists' education and utilization: Results of a survey. Education and Training Survey, *HFES Bulletin,* 2004

**Topic 2. Defining the machine**
Difference between machine and computer. Relation to Ergonomics and Human Factors to Human-Computer Interaction. Problems and challenges.

**Topic 3. Human information processing**
Human cognitive and sensory limitations. Models of cognitive architecture. Human problem

solving.

**Topic 4. Human memory.**
Declarative and implicit memory. Recall vs. recognition. Addressing problems of automation & situation awareness.

**Topic 5. Usability engineering or design.**
Usability engineering tools: Storyboards, Paper Prototypes, and Mockups.

**Video:** Five Days at IDEO. Redesign of the shopping cart.

1. Sommerich, C. M., et al. (2001). Effects of computer monitoring viewing angle and related factors on strain, performance, and preference outcomes. HF, 43, 39-55.
2. Cham, & Redfern, M. (2001). Effect of flooring on standing comfort and fatigue. HF, 43, 381-391.
3. Simeonov, P. I., Hsiao, H., Dotson, B. W., & Ammons, D. E. (2003). Control and perception of balance at elevated and sloped surfaces. HF, 45, 136-147.

**Topic 6. Design rules**
Basic design rules types: Standards; Guidelines; Golden rules, heuristics, or Rules-of-Thumb

**Topic 7. Design process rationale**
Prototyping and task analysis implementation

**Topic 8. Human-Computer Interface**
HCI in the software process, Iterative design practices, dialog as main interaction form

**Topic 9. Overview of methods of design evaluation tools**
Conceptual Models of Interaction evaluation: philosophy, task analysis, link analysis, critical incident technique.

**Supplementary readings:**
1. Vicente, K. J. (2002). Ecological interface design: Progress and challenges. HF, 44, 62-78. (philosophy)
2. Rogers, W. A., et al. (2001). Analysis of a simple medical device. Ergonomics in Design, p. 6-14. (task analysis)
3. Smith, H., et al. (1992). The ergonomic analysis of a trauma resuscitation room. Health Bulletin, 50, 252-258. (link analysis)
4. Cooper, J. B., et al. (1978). Preventable anesthesia mishaps: A study of human factors. Anesthesiology, 49, 399-406. (critical incident technique)

**Topic 10. Basic Experiment Designs**
Difference between observational methods, query techniques, physiological and direct recording, and experimental methods.

**Topic 11. Analysis Experimental Design**
Types of experimental designs. Detect sample size, issues in conduct and running Web Experiments.

**Topic 12. Analysis Experimental Data**
Between- and within - subject design in R: parametric versus nonparametric tests.

**Topic 13. Gather user needs**
Techniques to gather user needs: Interviews, focus groups, observation, participatory design

**Topic 14. Study of User Preferences by asking right questions**
Validity in Survey Design and Analysis.

**Topic 15. Review and final project (homework) description**
See assessment section.

## 11. Term Educational Technology

The following educational technologies are used in the study process:
- discussion and analysis of the results during the computer exercises;
- regular assignments to test the progress of the student;
- consultation time on Monday mornings with lecturer and after lecture;
- teleconference lectures
- office hours and classes with tutor and teaching assistants
- tutorship

## 12. Recommendations for course lecturer

Course lecturer is advised to use interactive learning methods, which allow participation of the majority of students, such as slide presentations, combined with writing materials on board, and usage of interdisciplinary papers to present connections between probability theory and statistics. The course is intended to be adaptive, but it is normal to differentiate tasks in a group if necessary, and direct fast learners to solve more complicated tasks.

## 13. Recommendations for students

The course is interactive. Lectures are combined with exercises. Students are invited to ask questions and actively participate in group discussions.

The lecturer is ready to answer your questions online by official e-mails that you can find in the "contacts" section**.** Additional references found in section 15.2 are suggested to help students in their understanding of the material. This course is taught in English, and students can ask teaching assistants to help them with the language.

In addition to introductory classes on R language you may find useful course from Coursera: https://www.coursera.org/course/rprog

## 14. Final exam questions

The final exam will consist in fifteen questions equally weighted. No material is allowed for the exam. Each question will focus on a particular topic presented during the lectures.

## 15. Reading and Materials

We do not follow a particular textbook in this subject, but the student may find the following references useful:

### 15.1. Recommended Reading

1. Human-Computer Interaction (3rd Ed): by Alan Dix, Janet E. Finlay, Gregory D. Abowd, and Russell Beale
2. Norman, Donald A."People are from earth, machines are from outer space." ACM Interactions 16.1 (2009): 39-41
3. Zaharias, P. "Developing a usability evaluation method for e-learning applications: beyond functional usability." International Journal of Human-Computer Studies 25.1 (2009):75-98

### 15.2. Supplementary Reading

4. David Easley and John Kleinberg. "Networks, Crowds, and Markets: Reasoning About a Highly Connected World." Cambridge University Press 2010.
5. Eric Kolaczyk, Gabor Csardi. "Statistical Analysis of Network Data with R (Use R!)". Springer, 2014.
6. Stanley Wasserman and Katherine Faust. "Social Network Analysis. Methods and Applications." Cambridge University Press, 1994
7. Shackel, B. Ergonomics for a computer. Design 120 (1959), 36–39.
8. Shackel, B. Human-computer interaction - Whence and whither? Interacting with Computers (IWC) 21, 5–6 (2009), 353–366.
9. Hewett, T. et al. ACM Curricula for Human-Computer Interaction. 1992; http://old.sigchi.org/cdg/index.html
10. Myers, B.A. A brief history of human-computer interaction technology. interactions 5, 2 (1998), 44–54.
11. Grudin, J. Brian Shackel's contribution to the written history of human-computer interaction. Interacting with Computers 5–6 (2009), 370–374.
12. Carroll, J.M. Human computer interaction (HCI). In Encyclopedia of Human-Computer Interaction. M. Soegaard and R.F. Dam, eds. The Interaction Design Foundation, Aarhus, Denmark, 2009; http://www.interactiondesign.org/encyclopedia/human_computer_interaction_hci.html
13. Nickerson, R. Man-computer interaction: A challenge for human factors research. Ergonomics 12, 4 (1969), 501–517.

### 15.3. R programming

1. W. N. Venables, D. M. Smith and the R Core Team. An Introduction to R, 2016 https://cran.r-project.org/doc/manuals/R-intro.pdf
2. Robert Knell. "Introductory R: A Beginner's Guide to Data Visualisation, Statistical Analysis and Programming in R", 2013

### 15.4. Popular Reading

1. Norman, D. A. (2013). The design of everyday things: Revised and expanded edition. Basic books.
2. Vicente, K. (2010). The human factor: revolutionizing the way we live with technology. Vintage Canada.
3. Weinschenk, S. (2011). 100 things every designer needs to know about people. Pearson Education.

### 15.5. Course webpage

Students are provided with links to the lecture notes, problem sheets and their solutions, assignments and their solutions, and additional readings.

## 16. Equipment

The course requires a laptop and projector.
R statistical modeling environment, RStudio IDE
R: http://www.r-project.org
RStudio: http://www.rstudio.com

Lecture materials, course structure and the syllabus are prepared by Alexey Klimov.