Development of working life skills and competences in a Master’s level project-work course

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Aalto University
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School of Electrical Engineering
MSc Programmes (120 ECTS)

- Automation and Electrical Engineering
- Information and Communications Technology
- Nano and Radio Sciences

- The School has 3 Master’s Programmes.
- AEE is by far the most popular.
- We are expecting more than 120 students.
MSc in Automation and Electrical Engineering
Prof. Anouar Belahcen

Joint Courses:
- ELEC-E8001 Embedded Real-time Systems (5 op)
- ELEC-E8002 and ELEC-E8003 Project work (A+B, 5+5 op)

15 cr

Translational Engineering
Prof. Mervi Paulasto-Kröckel
- Health and wellbeing
- Smart system integration
- Smart living environment

20 cr

Electric Power and Energy Engineering
Prof. Marko Hinkkanen
- Power Systems and HV Eng.
- Electromechanics
- Power electronic systems
- Sustainable Electrical Energy

20 cr + 10 cr

Control, Robotics and Auto. Systems
Prof. Ville Kyrki
- Robotics
- Automation Software Eng.
- Factory Automation
- Smart Systems
- Control Theory / Eng.
Tyyli-”flowchart” for Master’s Programme in Automation and Electrical Engineering

Phase 1

Master’s Programme in Automation and Electrical Engineering

- Curriculum mapping
- Competence matrix of all compulsory courses (n=15)
- Data based on curriculum (Oodi IT platform), MyCourses and responsible teacher interviews.
- Teaching methods, Group working skills, Oral communication skills, Written communication skills, IT skills, Project management skills, Problem solving skills, Research and knowledge acquiring skills, International skills, Practical exercises and works, Assessment criteria
<table>
<thead>
<tr>
<th>Course</th>
<th>Teaching methods used</th>
<th>Group working skills</th>
<th>Oral communic. skills</th>
<th>Written communic. skills</th>
<th>IT skills</th>
<th>Project management skills</th>
<th>Problem solving skills</th>
<th>Research and knowl. acquiring skills</th>
<th>international skills</th>
<th>Practical exercises and works</th>
<th>Assessment criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELEC-E8001</td>
<td>Lectures (3hr/week) Exercises (1hr/week)</td>
<td>Mini project (group of 3 students)</td>
<td>Active discussion during exercise sessions</td>
<td>Mini project (6-10 page professional-looking report)</td>
<td>Programming skills included</td>
<td>Mini project</td>
<td>Homework</td>
<td>Mini project (International groups highly encouraged)</td>
<td>Homework</td>
<td>Homework 15%</td>
<td>Homework 70%</td>
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<tr>
<td>Embedded Real-Time systems (5 CR), W</td>
<td>Homework Mini project</td>
<td></td>
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<tr>
<td>ELEC-E8002</td>
<td>Lectures Design of the project work</td>
<td>Group of 3-7 students</td>
<td>Presentation of the project plan</td>
<td>Project plan</td>
<td>All groups have one project manager</td>
<td>Project work</td>
<td>Project work</td>
<td>International and multidisciplinary groups targeted</td>
<td></td>
<td>Not defined yet</td>
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<tr>
<td>Project work course A Theory (5 CR), W</td>
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<tr>
<td>ELEC-E8003</td>
<td>Execution of the project work</td>
<td>Group of 3-7 students</td>
<td>Project work presentation</td>
<td>Project work report</td>
<td>Many project works require programming</td>
<td>All groups have one project manager</td>
<td>Project work</td>
<td>Project work</td>
<td>International and multidisciplinary groups targeted</td>
<td>Target for most of the projects is to build a device, prototype, etc.</td>
<td>Not defined yet</td>
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<tr>
<td>Project work course B Practice (5 CR), W</td>
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<tr>
<td>ELEC-E8405</td>
<td>Lectures, problems solving exercises and 2 assignments</td>
<td>Groups of 2</td>
<td>Dialogue</td>
<td>Request for clear written reports for assignments, assistance available</td>
<td>Matlab and Simulink</td>
<td>Problems solving exercises and assignments</td>
<td>Mixed Finnish and international students, working language English</td>
<td>Relevant assignments</td>
<td></td>
<td></td>
<td>30% Assignments 70% Exam</td>
</tr>
<tr>
<td>Electric Drives (5 CR), JM</td>
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</table>
Tyyli-”flowchart” for Master’s Programme in Automation and Electrical Engineering

Phase 2

Selection of three main competences based on Aalto, ELEC & EAA strategy
- Group working, Project management and Multicultural skills
- Analysis on skill development routes including all compulsory courses for the three majors (CRAS, EPEE &TE)
- Three levels (High, Moderate and Low)
- Distribution of these skills also through the two year master program to rationalize the student workload in each semester.
### Selection of a key course for the whole Master’s Programme

- **Project Work**, theory and practice, 10cr
- **Quiz to students including the 26 competences & scale from TEK survey**
  - “How important do you find this competence for your future working life after graduation?”
  - “How well has the project work course supported your development in this area?”
  - “Overall, how well have all the courses in the master’s program that you have passed so far supported your development in this area?”
- Few additional questions for the program and course development
- Three project work groups (four students per group) was also interviewed

## Skill development routes

<table>
<thead>
<tr>
<th>Skill</th>
<th>Group working skills</th>
<th>Project management skills</th>
<th>International/multicultural skills</th>
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</thead>
<tbody>
<tr>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
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</tbody>
</table>

### 1st Year Period 1-2

- ELEC-E8001 Embedded Real-Time systems
- ELEC-E8730 Design of electronic equipment
- ELEC-E8712 Design for reliability

### 1st Year Period 3-5

- ELEC-E8002/3 Project work A, B
- ELEC-D8710 Principles of materials' science
- ELEC-E5710 Sensors and measurement methods

### 2nd Year Period 1-2

### 2nd Year Period 3-5

Reserved for M.Sc. thesis

### Health and wellbeing

- ELEC-E8734 Biomedical instrumentation
- ELEC-E8726 Biosensing (period 2)
- ELEC-E8726 Biosensing (cont., periods 3-4)

### Smart System Integration

- ELEC-E8714 Sustainable electronics
- ELEC-E8711 Materials compatibility
- CHEM-E5115 Microfabrication

### Smart Living Environment

- ELEC-E8101 Digital and Optimal Control
- ELEC-E8102 Distributed and Intelligent Automation Systems

### Measurement Science and Technology

- ELEC-E5720 Virtual instrumentation
- ELEC-E8732 Instrumentation electronics
- ELEC-E8731 Design of electronic prototype
### Phase 4

Selection of a key competence for the whole Master’s Programme

- Multicultural skills
- Workshop consulted by Carlos Mendoza
- Analysis & Development work for five courses
  - ELEC-E8002/3 - Project work A/B
  - ELEC-E8406 Electricity Distribution and Markets
  - ELEC-E8700 Principles and fundamentals of lighting
  - ELEC-C1320 Robotiikka (Robotics)
  - ELEC-E8712 Design for reliability
Multicultural Teams

• Definition
• Challenges and liabilities
• Assets
• Management
Multicultural Teams
Definition

• Teams whose members come from different nations and backgrounds (Brett et al, 2007)

• A group of people from different cultures, with a joint deliverable for the organisation or stakeholder (Stahl et al, 2010)

• Three or more cultures are represented (Adler et al, 2008)

Multicultural Teams
Challenges and liabilities

• Concepts
  - Cultural friction
  - Cultural incompatibility
  - Culture clash
  - Culture shock
  - Culture novelty

“Cultural differences may create substantial obstacles to effective teamwork.”

• Teamwork
  - Communication
    • Styles, accents and fluency
  - Social conducts
  - Values and attitudes
  - Personalities

• Team management
  - Manager’s multicultural competence
  - Manager as facilitator, motivator, teacher, instructor, psychologist, ...
Multicultural Teams

Assets

Foster learning, creativity and innovation
  • Variety of knowledge and perspectives

Increased satisfaction
  • Successful handling of inherent demanding challenges

May enhance communication effectiveness
  • If teams make deep-level elements of cultural diversity salient

Multicultural Teams Management

Managerial interventions

• Promote dialogue
• Organise convivial activities
• Create rules of engagement
  - Use of language
  - Task structuring
  - Assigning roles and responsibilities
• ...

• Team formation
  - The use of algorithms

A Multicultural Group-forming Algorithm

- An earlier version and development
- The new algorithm
A Multicultural Group-forming Algorithm

• Initial development in a trial course, Electricity Distribution and Markets

• An earlier version, developed by Eero Saarijärvi and John Millar simply:
  • placed one international student in each group
  • If there were more than international students than groups
    • The remaining international students were randomly distributed to groups such that there was no more than one international student from the same country
    • The Finnish students were then randomly distributed to the groups

• Because of this (or despite this!), the group work has been considered the main learning tool in the course
Development From an Earlier Version

This year, because John didn’t get the new algorithm working in time, the groups in his course (Electricity Distribution and Markets) were distributed in much the same way, except that some cultural difference between Finns was heuristically considered – not very well, hence the need for an algorithm...

Examples of cultural differences other than nationality or ethnicity or language – encouragement for opening the definition of culture came from fellow-student feedback in this course☺

• Academic background
• Technical/professional background
• Region of Finland background
• Gender
• Personality type, religion, beliefs, attitudes, values, norms, dressing, appearance, food habits, time consciousness, etc...
The New Algorithm

Input data:

- Attributes per student (ranked from 1-5 in terms of relevance for course activity), e.g.:
  - Academic attributes
    - Prerequisite or recommended courses
    - Study path
    - Relevant skill sets – e.g., maths, programming, etc.
  - Personality attributes, e.g., the “big five”
    - Conscientiousness
    - Agreeableness
    - Emotional Stability
    - Extraversion
    - Openness to Experience

- Inter-student attributes (ranked in terms of cultural distance between each student)

So! To summarize...

- The Tyyli trio from EEA Aalto have learnt a lot from this course, (Työelämäyhteistyö Yliopisto-opetuksessa), thanks!
- The Tyyli quartet, among other things, will, in the remainder of 2017: Septet!
  - Finish a teaching guide:
    - *A practical guide for engineering education*
      - Case-study examples
      - An invitation for teachers to implement the principles of good learning facilitation in a way that suits the situation
  - A group-forming algorithm (we are engineers, among other things...)
    - *For this and all things, we value input from the wider community so that we can in turn offer something of benefit!*

THANKS?