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Coordinator: Princess Sumaya University for Technology (PSUT), Jordan
Project Manager: Professor Abdallah Al-Zoubi
Address: Khalil Saket Street 118, Amman 11941, Jordan
Tel: +9626 5359949/+9627 77355299
Fax: +9626 5347295
Email: zoubi@psut.edu.jo
Project Website: http://muree.psut.edu.jo/Home.aspx

Deliverable Title	***Workshop on Curricula Updating- Minutes of Meeting***		
Author(s)	***Maria Hadjipanayi***		
Organisation Name(s)	***University of Cyprus (UCY)***		
Deliverable No.	**2.1**		
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A workshop was held in Graz University of Technology, Graz, Austria, in the period 10-13 April 2013 to discuss curricula updating of renewable energy courses, jointly with DEV5.1 on Development a Capacity Building Programme, with the following participants:
1. Issa Batarseh, Princess Sumaya University of Technology, Jordan
2. Ayman Faza, Princess Sumaya University of Technology, Jordan
3. Qais Kasawneh, Jordan University of Science, Jordan
4. Suhil Kiwan, Jordan University of Science, Jordan
5. Ahmed Al Salaymeh , University of Jordan, Jordan
6. Hala Khyami- Horahi, University of Jordan, Jordan
7. Ayman Al Quadah, University of Jordan, Jordan
8. Ayman Al-Maaitah, Mutah University, Jordan
9. Handri Ammari, Mutah University, Jordan
10. Ahmad Al-Khasawneh, Hashemite University, Jordan
11. Mohammad Al-Abed, Hashemite University, Jordan
12. Bashar Hammad, Hashemite University, Jordan
13. Monsour Al Hallaj, NETenergy, Jordan
14. Rafael Jiménez Castañeda, IGFOTON, Spain
15. Salvador Ros, UNED, Spain
16. Juan Peire, UNED, Spain
17. Maria Hadjipanayi, University of Cyprus, Cyprus

18. Katiuscia Cipri, Sapienza University of Rome, Italy
19. Jens Palacios, TU Berlin, Germany
20. Annette Mütze, TU Graz, Austria
21. Klaus Krischan, TU Graz, Austria

April 10, 2013

[1] Presentations by A. Muetze and Prof. Fickert, Dean of Studies of Electrical Engineering and Information Technology

- Presentation of Graz University of Technology, Field of Expertise "Sustainable Energy" (30 institutes from within TUG, not a degree programme, organizational structure for concerted effort in this area)
- Electric Drives and Machines Institute
- Graz: Bachelor/Master's system
- Discussion for feedback scheme used in Graz for courses offered

[2] Presentation of WP1–part curriculum (Kiwan, JUST)

Topic: Analysis and recommendations for curricula development (report sent to partners prior to meeting)

Contents: (i) Objectives, (ii) Overview of REEE market (iii) Methodology (iv) Labour market survey (v) Survey results (vi) Conclusions/recommendations.

Methodology: 23 organizations (almost all RE companies interviewed in Jordan), SME, businesses, energy management services, RES productions, retailers, etc.

Results

- Important areas of interest: sales, marketing, installations, design and engineering, production
- Training: mainly on-job training
- Lack of professionals in the REEE market, lack of technical expertise +qualifications, lack of management expertise
- Skills sought: technicians, vocational qualifications, engineers (basic and RES specialization)…
- Topics needed most: solar energy, thermal applications, controls, Solar–PV, wind RE management

Guidelines for Courses

- Need for qualified professionals
- Need for technical expertise
- Competences needed: design, installation, analysis and modelling
- Topics needed most in labour market: Solar thermal applications (CSP) and design, solar PV, PV controllers, wind RE management

Discussion

Comments from JUST

1.Another questionnaire sent to other universities in Jordan to fill out to know academic research activities in RE in Jordan to cover all aspects of RE (academic, industry/market).

2.23 interviews with companies, pretty much all companies in Jordan involved in RE work. Mainly involved in RE issues (only small part of their businesses are in EE).

3.What about EE? Need also expertise in civil engineering/architecture to design courses in EE and E management, auditing systems, certification… (statistically in the survey more needs in RES rather than EE showed up).
Comments from Graz: Narrow down to 4 pilot courses based also on the expertise of the EU partners who will help with the design of the courses. If more are produced maybe we can vote which ones to choose?
Dr .Annette Mütze, TUG: try to find titles for the courses.
Dr. Issa Batarseh, PSUT: need 4 core courses and can't cover all specialities, the course focus depends on the department they will go under (Electrical Engineering, business). This is why it was suggested to develop additional courses so that Mechanical and Electrical engineering departments cover the topics from their own prospective.
JUST: can include various topics not in core course but also in the training workshops.
Existing courses→ need to improve them → Jordanians responsible to do this if they want.
EU partner expertise:
(i) TUG: masters El. Eng, combined specializations) ; course at bachelor level in RE (Part 1: Intro to all sorts of RE, Part 2: digging deeper (e.g. PV)), other relevant courses offered are for example electric drives and machines and mechanical energy conversion)
(ii) UCY: PV, Power electronics
(iii) Sapienza: EE +RES course to students focus on technical aspects: software, design RE plant (successful)
(iv)TUB: Complete master's program on RES (all kind of engineers): global production engineering.
Dr. Issa Batarseh suggests a general course on RE (30% PV, 30% wind).
JUST supports a more specialized course.
Good idea to have an overview general course on RE (1st, 2nd year)
Cadiz: 2 curricula design (i) academics (ii) professionals
Jordanian Universities existing courses:

- HU: in RE, energy conversion, PV exists
- JUST – RE course exists
- PSUT – El. Machines, RE, Energy Conversion, etc exist

Proposed courses (initiated by Dr Annette Mütze):
Keywords: 2-core (2nd, 3rd year?), 2 advanced level (3rd, 4th year?), bachelor:

- PV: advanced (UCY, HU, PSUT)
- Electric drives and machines: TUG, PSUT
- Mechanical components of RE (focus solar) - energy conversion (covers RE basics), TUB, JUST
- Renewable Energy (RE) systems course foundation/basis: [Part1: Intro to all sorts of RE, Part 2: digging deeper (e.g. PV))] – Sapienza, MU

Other proposal (by Juan Peires, Spain):

- Mechanical : wind, water
- PV energy
- Thermal/Biomass/Geothermal
- System

Suggestion by Jordanian partners (already have courses/expertise): people groups for pilot courses, leaders from JO, EU partner, other partners and persons involved discussed in the large group.

Course Name	PSUT	UJ	MUTAH	HU	JUST	EU	Leaders from Jordan	Partners	Persons involved
Energy conversion	✓	✓	✓	✓		Sapienza	UJ	PSUT, MUTAH	Katiuscia, Ahmad + Odah
RE systems	✓	✓	✓	✓		Sapienza	HU	PSUT, UJ, MUTAH	Katiuscia, Bashan +Ahmad +Handri + Khasw
PV	✓	✓	✓	✓	✓	UCY	PSUT +HU	UJ, MUTAH, HU, JUST	Maria, Issa, Mohamet +Monsoon
Solar Energy (thermal)		✓	✓		✓	TU Berlin	MUTAH	UJ, JUST	Jens, Ayman M + Kais
Wind energy			✓		✓	TU Berlin	JUST	MUTAH	Jens, Suhil, Maiteh
Electric machines and drive	✓			✓	✓ RE in electronics	TU Graz	PSUT	HU, JUST	Annette, Ayman F, Klaus

Leader tasks:

- Driving force
- Course content: from EU (a general content) on Jordanian request

EU: send a general curriculum content and expect feedback from Jordanians on making the course customized to their needs, and send more help back. Also, the Jordanian partners requested the development of detailed course material, and asked each EU partner to send what they have (even if notes written in non-language).
EU universities request Jordanians to send them the program of their courses they give.
Deadline for pilot courses: August 15th, 2013

[3] Presentation – labs (By Prof. Kiwan)

- Remote and online labs

Equipment for remote labs established in: HU (in PV), PUST, JUST, MUTAH
(i) Wind and solar power trainer setup: teach students characteristics of solar panels and wind power generators (22k):
(ii) Alternative energy trainer: theory of generating power from solar, wind, fuel cells, (18k)
(iii) Power quality trainer: analysis tools (14k)
(iv) Solar tracking control trainer (19k)

(v) HU needs to send EU partners the specifications of the remote labs and EU partners give feedback

- 2 E-learning courses (HU, UNED responsible to design them): convert course offered for the internet, plus extensive exercises, calculations, beyond the course (this is not remote labs)

Courses selected: PV + Second Course to be decided*

- Traditional labs and Station at PSUT

*2nd Course suggested: RE (by HU) and WIND. HU suggests RE course as a second course because:

1) Four Jordanian partners are interested in RE and only two in WIND.

2) HU will develop e-learning courses and HU has experts in PV and RE and no experts in WIND. In addition, this is why we took the lead for developing curricula for PV and RE courses.

Comment from Salvador Ros (UNED) about the necessity to have copyright clean contents for the online courses

[4] Break into groups to determine each course outline

Discussions about: Topics; Wish list for better course; Next steps to achieve these

April 11, 2013

MUREE Announcement: "Dissemination, Quality and Steering Committees meeting will take place at PSUT on 23-247 October 2013."

Meeting starts with the presentation of pilot courses programme elaborated the day before.

"Electric machines and drives" was the first course presented. An accurate scheduling and a list of suggested books have been proposed. Some Jordanian colleagues underline course seems to be designed for electric engineers. A proposal is also to include the last week of the course an introduction to renewable energy technologies (n. 1 topic and module). Prof Kiwan asks about courses that students have to attend before this course. Other professor from Austria underlines to give the right time to students to well understand the topic also repeating the same topic for more times and showing applications of the concepts. Salvator Ros (UNED) introduces a general point of view for e-learning courses: all contents have to be adapted to e-learning system. Teachers create our materials. In fact to include contents or exercises taken from other books is not permitted, and a specific permission has to be asked for. This is valid for all the cources which will be included in the distance learning.

"Wind Energy Technology" course has been elaborated starting from Prof Kiwan scheduling. First proposal is to include in Aerodynamic also Wake rotation, rotor performance and calculation, effect of Drag and lade number topics. Second proposal is to include electrical aspects of wind turbine (electric power, transformers, electric machines and power converter). Course finishes with a part on economical aspect. Prof Al-Salaymeh asks for a project design in the course. Prof Kiwan explains what he aspects from the students (understand of fluid dynamic, design turbine, predict performance. The last question of Prof Al-Salymeh is if a software will be used. Prof Kiwan replies he will show SEM a free software elaborated by an international research centre. Jens says the programme could be developed in two semesters: the first theoretical semester and the second project oriented. A proposal could be to have wind (1) and wind (2), also because no information are available on previous courses attended by students before this course.

"Renewable Energy systems" opportunity to analyse the course provided in Italy. First problem in Italy there is a 60 hours course, instead in Jordan there is a 40 hours course. Jordanian course doesn't take in consideration energy efficiency as in Italy. For PV, Solar Thermal and Wind, the

following topic will be carried at: introduction, theory, component, sizing, regulation and cost. Biomass, Hydro and Geothermal will approach avoing sizing. Software suggested for sizing is HOMER. Prof Ammari suggests to put Solar Thermal before PV. To reduce Hydro to 2 hours. Prof Maitah suggests to include totalistic approach and economical aspects, comparing systems and efficiency (capacity factor), without enter in so specific aspects. Prof Ammari says this course is not so specific. Prof Kiwan says RE Systems and Energy Conversion are two basic courses. To include why renewable Energies and Hybrid Systems.

	Sugg. Topics	**Hours sapiensa**	**Hours suggested**	**intro**	**Theory**	**Component**	**Sizing**	**Regulations**	**Cost**
1	Into	4	4						
2	PV	10	10	X	X	x	X	x	x
3	Thermal solar (CSP)	10	10	X	X	X	X	X	X
4	Wind	8	8	X	X	X	X	X	X
5	Bio	6	4	X	X	X		X	X
6	Hydro	4	2	X	X	X		X	X
7	Geothermal	2	2	X	X	X		X	X
		44	40						

“Energy Conversion”, Prof Al-Salaymeh says they have not enough time to discuss about the new programme. He shows a list of topic, including conventional sources and renewable sources. Prof Kiwan underlines this course as to give students information on energy conversion processes, no information on technologies and plants. Prof Kiwan suggests also to include Nuclear energy and energy storage. A question relating the difference between Energy conversion and Renewable energy systems have been emerged. The problem is not repeat the same topics in two different courses. Most partners have both courses. Jordanian partners decide to have the same leader for both courses: Renewable energy systems and Energy Conversion. Problem is that the 2 courses are elective in all Jordanian universities.

“Photovoltaic”: Maria explains the syllabus of PV courses. They have identified pre-requisite (compulsory courses). Course includes fundamental physics of material, photo generation and photovoltaic effect. Prof Al-Salaymeh asks two questions: where will be analysed all components (inverter, controllers, monitoring systems), if could be included stand-alone systems. Other suggestion is to introduce innovative technologies as CPV. Prof Kiwan asks to underline topics which need more electrical information and knowledge in order to prepare students on these. He says mechanical students have problem with electric topics and they have to prepare on this. Question is also what market needs and if the course has to transfer more technical and practical competences, also providing information on technical aspects of installation. Prof from PSUT suggests to introduce another topic on “Practical challenges that need to be address…PV installations”. Prof Kiwan suggests to introduce hours for educational labs and a topic on Hybrid PV systems. Rafael says that for engineer is important to know industrial text for modules and components certification, texts for quality control, maintenance, hot spot, energy lost for hot spot, etc. Jens says that need two big modules, one on cells (PV 1)

and one on module (PV 2), with peripheral topics that can include also recycle of PV components. Prof PSUT suggests to send two different programme, one for electrical background and one for mechanical background.
"Solar Thermal Systems" Prof Maitah shows a proposal for the syllabus. It includes also the Solar cooling Technology and CSP systems. For alla technologies, economical aspects will be analysed. Prof Al-Salaymeh says they use to train students on the basis of radiation and optical aspects. Prof Kiwan invites to include part in which explain how to integrate solar systems in different technologies. To introduce in CSP (eliminating P) the use of solar concentrator in industries. Prof. (Spagnolo) suggests to include also theory on energy transfer, but Prof Maitah answers courses on energy transfer are compulsory. Other suggestion is to include automation and tracking mechanisms, also in consideration of students come from mechanical competences.

Methodology for Preparing Courses' Material
Deadline for courses' materials: August 15th
1.A template will be designed by UJ with main information and topics (objectives, description/overlapping area, modules, course's contents, audience/background needs, pre-requisites, outcomes, suggested text books/references, etc)
2.Materials: word file for each chapter, .pdf and .ppt, films, video. Starting from materials Jordanian partners have.
3.Course's leader will circulate the programme/outlines by May 1st ;
4.E-learning materials: copyright problem.

Role of partners: Jordanian partners will exchange about courses and the contribution of EU partners will be weighted on the budget and project indication (about 50% from Jordan and 50% from EU).

Overall Role of EU: Support the Jordanians to outline their courses (they form outline, send to EU partners for feedback, we suggest our practices, and the Jordanians accept/decline according to their needs. Jordanian partner contacts EU partner to decide on the mechanism of the development of the courses.

Two pilot courses outlines are presented below:
Title for pilot course: Photovoltaic Systems
Three-credit hour course
Course: pre-requisites:
Electronics I (semiconductor materials, diodes, transistors, feedback circuits)
Level: Junior-senior level
If module too much or too advanced, possibly break up into 2 courses? PV I (fundamentals of cells), PV II (modules, arrays, input from TUB)

Contents
1.Introductory overview
2.The solar resource
3.Semiconductor physics
4.Solar cells
5.PV array and modules
6.PV systems
7.Distributed versus centralized solar PV generation, BOS design, Intro to smart-grid for PV

systems
8.Recent advances and challenges in PV systems:
Addressing continued challenges: concerns with high penetration, grid stability, cost, dust, high temperature, reliability, intermittency, and dynamically instable energy.
Introduction to BIPV, energy management, energy policy and regulations.
9.Practical challenges that need to be addressed ... PV installations

Detailed Contents

1.Introduction overview

Overview of Energy
Environmental and Social threats
Energy Crisis
Solar Potential
Photovoltaic applications and market potentials
Photovoltaic energy in Jordan

2.The solar resource

The solar spectrum
The earth's orbit
Altitude angle of the sun at Solar Noon
Solar position at any time of day
Sun path diagrams for shading analysis
Clear sky direct-beam radiation
Total clear sky insolation on a collecting surface

3.Semiconductor physics

Intro
Basic semiconductor physics
A generic PV cell
From cells to modules to arrays
The PV I-V curve under STC
Impacts of temperature and insolation on I-V curves
Shading impacts on I-V curves

4. Solar cells

Solar cell structure
Collection probability
Spectral response
Photovoltaic Effect
Operation parameters
Effect of Parasitic resistance
Effect of temperature
Effect of Irradiance
Solar Cell - Manufacturing
Introduction to major PV technologies
Introduction to manufacturing of solar cells
I-V curves for loads
Stand alone and Grid-connected systems and economics

5.PV modules and array
PV system analysis
Module performance
PV interconnection effects
Reasons for underperformance

6.PV systems
PV markets and driving forces
PV systems
PV system performance
PV system design and sizing ... components
PV tracking systems
PV performance
Energy prediction
PV Business – Manufacturing Costs

7.Distributed solar PV generation
Distributed (DG) versus centralized solar PV generation
BOS design
Intro to smart grids: advanced metering infrastructure AMI
Micro-grids

8.Recent advances and challenges in PV systems
Challenges of high penetration, dynamic pricing – cost issues,
Introduction to BIPV,
Energy management
Policy

9.Practical challenges that need to be addressed ... PV installations

Title of pilot course: Introduction to Electric Machines and Drives
Equivalent to Electrical Machines 2 course in PSUT the electrical power and energy curriculum

Course Topics
Theory
Motivation (1 hr)
• Load types and characteristics
• Practical issues of machine and drive selection

Review: Electromagnetics and Energy Conversion (2 hrs)
• Ampere's law
• Faraday's law
• Gauss's magnet law
• Magnetic circuits: electrical-magnetic analogy
• Magnetic flux
• Soft magnetic materials
• Inductors and transformers

• Forces: Lorentz and Reluctance
• DC machine

Review: AC Systems and Three-Phase Circuits (2 hrs)
• AC voltages and currents
• Complex numbers and phasor concepts
• Why three-phase?
• Harmonics
• Per-unit system

Basics of AC Machines (4 hrs) (Spend more time on fundamentals)
• Elementary AC machines- air-gap MMF- flux- voltage waveforms
• Distributed stator windings
• Elementary rotor-stator coupling
• Three-phase operation

Synchronous Machines: Steady State (1 hr+2hrs as time permits)
• Synchronous machine types- smooth rotor- salient pole- permanent magnet
• Circuit models and vector diagrams
• Capability curves

Induction Motors: Steady State (1hr+2hrs as time permits)
• Induction machine types- wound rotor- "squirrel cage" rotor
• Circuit models
• Definition of slip
• Torque-speed curves

Converter Power Electronics: Basic Theory, Devices (3 hrs)
• Review of circuit fundamentals
• Basic converters: AC-DC, DC-DC, DC-AC, AC-AC
• Higher focus on DC-DC, and DC-AC. Mention buck and boost converters
• Device characteristics and capabilities

AC Inverter Basics: VSI, Modulation (3 hrs)
• Basic inverter system
• Voltage source inverter (VSI)
• Modulation techniques
• Pulse width modulation (PWM)
• Practical considerations

Adjustable Speed Drives: Basics (3 hrs)
• Basic adjustable speed drive systems
• Review: DC machine:
1.Speed control
2.Torque control
3.Cascaded control
4.Field weakening
• Varying voltage

• Motor and drive selection

Field oriented control (Special case: Field Oriented Control of Induction Motors) (4 hrs)
- Revisit IM model
- Physical representation of induction machine fields
- Basic IM vector drive
- Rotor flux orientation
- Field weakening
- Induction machine torque-slip control

Adjustable Speed Drives: Volts/Hz Control (1 hr)
• Concepts of constant flux and torque
• Operation at constant torque or power
• Low speed operation
• Basic Volts-per-Hertz system
• Drive limitations

Adjustable Torque Drives: Basics (1 hr)
• Ideal adjustable torque systems

Synchronous machine control (2 hrs)
- Synchronous machine control (notably PM machines)

Application-Specific Selection of Machine-and-Drive Systems (1 hr)
• Specific drives to suit application
• Case study

If time permits: Go back and talk more about steady state synchronous machines and induction machines (up to **4 hrs**)
Text Book: Introduction to Electric Machines and Drives; T. M. Jahns, T. A. Lipo, and D. W. Novotny.
Additional references: "Electric Drives" and "Advanced Electric Drives" by Ned Mohan
Practical: Experiments on speed control of synchronous Machines, Induction Machines, and Reluctance Machines
Comments: Need to add some more RE flavour, how does this relate to Wind Energy, Solar Energy technologies?

Accreditation
It seems each Jordanian University has a particular procedure for the accreditation. UJ has to submit new curricula to the Department. The same for JUST. JUST asks the process is critical because several department are involved in the accreditation and no all of them agree with the program. The accreditation is welcome but not compulsory. For MUTAH it seems not so difficult the accreditation. PSUT has courses on this topics, so there is no problem for the accreditation. HU has the same problem of JUST and will try external accreditation. UJ could not accredit a full e-learning course, but only as part of interactive course.
Special topics course: all Jordanian University can be used.