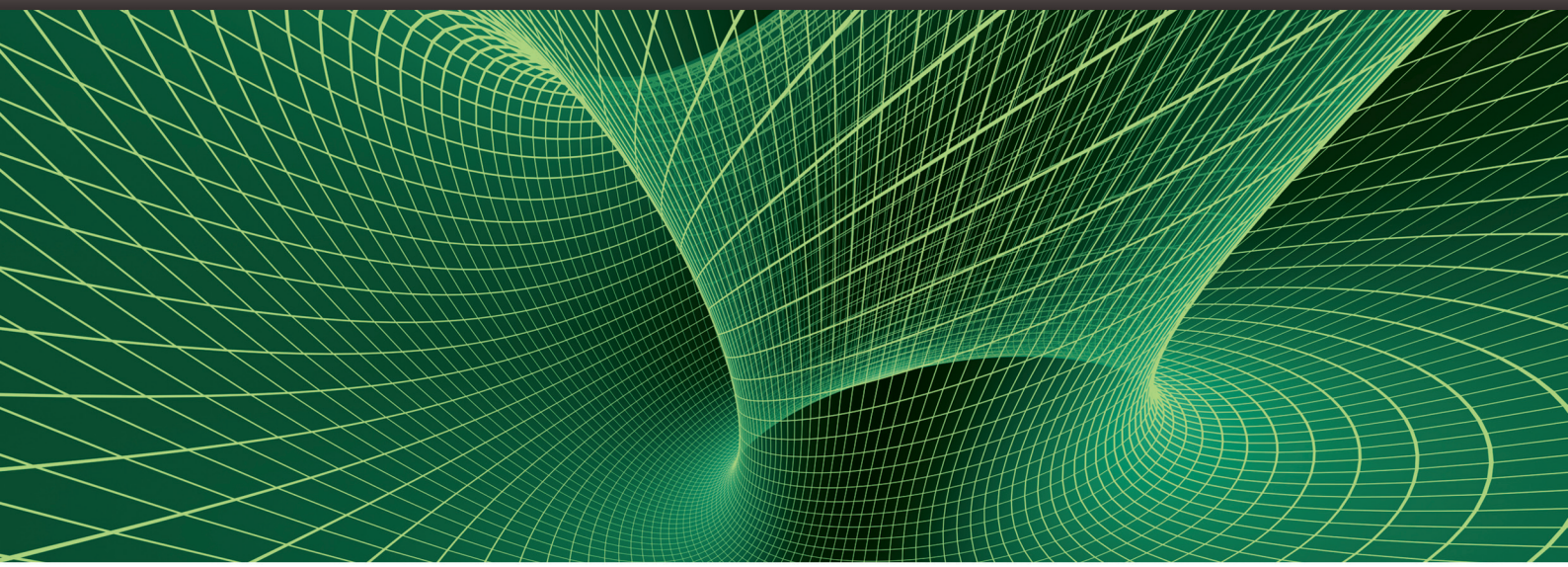

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Creation of university-enterprise cooperation networks for education on sustainable technologies

Course 4
Sustainable technologies and Materials engineering

European Commission
TEMPUS

Course 4
Sustainable technologies and Materials engineering

Short content of the course topics

Common topics for all courses
Sustainable technologies

1. Zero emission concept

The linear model of development seems not to be sustainable. The results are exhaustion of the natural resources and waste accumulation. The Zero emission model, as in nature, predicts the circulation of material flows and consequently reduces the emission of material and energy to a minimum, ideally zero. The amount of generated waste is minimum, because almost all flows are used. Besides environmental there is also economic benefit. The import of resources are minimum, local/regional resources are used efficently and new jobs are created.

The problem of waste control and reduction, can be handled by three concepts. The first is End-of-Pipe pollution control technologies, the second is Cleaner Production concept and finally the Zero emission concept. "The end of pipe" treatment or control of already generated waste while the Cleaner production involves the treatment of production needs more efficient use of resources by reducing pollution. The Zero emission concept, however, seems to be the final solution to waste control and reduction. However, the limits of the previous two concept have to be known. In the final Zero emission solution in the previous two concepts, especially Cleaner production, cannot be omitted.

The Industry with zero emission, industrial clusters, eco-industrial parks and circular economy are given as the practical impacts/benefits of the Concept.

2. Environmental sustainability and industry

Technology has a very important role in sustainable development. The technologies are used to extract resources and to get useful products. The linear model of development results in exhaustion of the natural resources and waste generation. The linear model of development is to be replaced by sustainable one like cyclic sustainable development model. The main component of both models is given and discussed. It is essential to have a clear picture of the main differences between these two models.

The possible impact on the environment during product or process life is given in the part Life cycle assessment (LCA): The effect of our activities is given in the following part Carbon footprint.

In the following it is explained which material is appropriate for eco design.

Sustainable agriculture and food production combine the goals of sustainable development. Sustainable technologies use less energy, fewer limited resources, do not deplete natural resources, do not directly or indirectly pollute the environment, and can be reused or recycled at the end of their useful life.

The Environmental Management System is important part of sustainability, especially related to industry. According to ISO 14000 the term Environmental Management means management with respect to all environment components. The Environmental Management System is part of an overall management system of the organization. The System includes organizational aspects, planning activities, responsibilities, procedures, procedures for developing, implementing, achieving, reviewing and maintaining environmental management policy.

The Environmental risk assessment also have important role in sustainable development. In this part of the course the concept of environmental risk assessment, environmental hazards and environmental risks, as well as risk analysis basic components

are given. The main stages in the implementation of environmental risk assessment as well as benefits are also covered.

3. Legislation

A comparative study of legislation in the field of environmental protection and sustainable development in The Former Yugoslav Republic Macedonia, Bosnia and Herzegovina and Serbia

In this part of the course the comparative study in three West Balkan's countries: The Former Yugoslav Republic Macedonia, Bosnia and Herzegovina and Serbia are presented. The study shows that there are similar solutions concerning environmental protection issue in all three countries. The differences in solutions are minor.

4. Sustainable technologies

"Green Chemistry" is a universally accepted term to describe the movement towards more environmentally acceptable chemical processes and products. Green Chemistry can be achieved by applying environmentally friendly technologies.

The next very important issue concerning sustainable technologies is BAT (Best Available Techniques). The BAT is focused on minimizing the amount and/or toxicity of the industrial waste. Best Available Techniques are defined as the most effective and advanced stage in developing activities and methods of waste operation.

The next parts of the course are: Waste water treatment, Air protection, and Recycling and Solid waste management.

5. Renewable energy resources

In this part of the course the renewable energy sources are presented. First part deals with basic concepts related to energy, energy distribution as well as definition of non-renewable and renewable energy sources of energy. The following parts describe the renewable energy sources: energy of the environment, geothermal energy, wind energy and solar energy. The ways of utilization and the advantages and disadvantages of each type of renewable sources are also given. The overview of implementation of renewable energy sources in West Balkans countries is also presented. In the next section biofuels are presented. The advantages and disadvantages of each biofuels are indicating as well as the possibilities of their production in the Western Balkans countries.

6. Energy efficiency of the technology processes

Technological processes are generally energy intensive. Reducing energy consumption, environmental protection and waste management become imperative to every technological process. Increasing energy efficiency, in addition to savings in energy consumption in the broad sense includes protection of the environment and very often minimizes waste. Rational energy use and recovery of waste heat from the process are the two most important ways of reduce costs. Utilization of waste streams and renewable sources are the following two tools in order to reduce costs and to preserve the environment and reduce waste.

To increase energy efficiency, extensive knowledge is required. The first step towards reducing the energy consumption is analysis. For this reason it is necessary to have a good understanding of material and energy balances. The next step will be to adopt a program of savings. As a rule, the first steps are savings that do not require or require very little material resources. The next steps are saving measures that require greater investment.

The savings can be achieved by each individual device and system as a whole. For this reason, it is necessary to have knowledge of each unit, as sources of potential losses. Devices that provide energy such as boilers and steam systems are found in almost every technology. Heating, cooling, air conditioning, insulation and lighting systems are also independent of the type of industry. There are also a certain amount of individual operations, specific for each technology.

Finally, it is necessary to know what the whole process energy reserves are, or what the maximum energy that can be recovered.

Specific topics

Course 4

Sustainable technologies and Materials engineering

The nowadays-fast development, which results in intensive way of leaving is as a consequence of the development of different kinds of materials which can be fined in various segments of everyday life. In the first part of the course in particular thematically parts are presented the different kinds of materials like: polymer materials, metals and alloys, ceramics materials, glass, composite materials and eco-composite materials. The following themes are also covered: science and engineering of materials, nanotechnology and non-material modern electronic economy. Particular attention is given to type and usage of materials starting from the modus operandi in science and engineering of materials i.e. the: *synthesis – structure – properties – application*.

The second part of the course thematically covered the treatment of waste in the materials engineering in general, but also the actual themes from the management of waste are presented like recycling of: polymers, metal scrap, glass and refractories. The production of ceramics from waste and end of life treatment of polymer composite materials present are also covered in this part of the course.

In this part of the course the particular attention was paid to the different types of materials, which can be treated as raw materials from which new or the same products can be produced. Also, the attention was paid to the treatment of waste as energy resource.

ECTS file

COURSE TITLE

Sustainable technologies and Materials engineering

COURSE OUTCOMES

At the end of this course "**Sustainable technologies and Materials engineering**" trainees will have a general knowledge of sustainability and will have specialised knowledge on sustainable technology and sustainability related to Material engineering. The trainees will be able to handle specific problems concerning sustainability and Material engineering

COURSE EDUCATIONAL AIMS

The course is a part of lifelong learning programme and aims at recruiting staff from **Pharmaceutical and cosmetic industry,** involved in dealing with sustainability. Newly graduated students are also welcome. The course starts with general knowledge on sustainability, proceeds with sustainable technologies and finally ends with specific sustainability problems and Material engineering. The general aim is to provide the students with the ability to implement the acquired knowledge and attitudes in industrial practice in order to establish a sustainable Material engineering practice. The educational general aims of the course are:

- to provide trainees with thorough knowledge and clear understanding of the sustainability concept
- to provide trainees with state of the art knowledge on sustainable technologies and sustainable food industry.

COURSE CONTENTS

The course covers the following topics:

1. The zero emission concept
2. Environmental sustainability and industry
3. Legislation
4. Sustainable technologies
5. Renewable energy resources
6. Energy efficiency of the technology processes
7. Materials Engineering
8. Polymer materials
9. Metals and alloys
10. Ceramic materials
11. Glass
12. Polymer eco-composite materials
13. Modern electrode materials in the hydrogen economy
14. Waste treatment in materials engineering
15. Case studies

ECTS credits

6

COURSE TEACHING METHODS/COURSE ASSESSMENTS

The teaching methods will largely recline on student directed learning are based on team work and peer to peer learning. This principle will be applied in creating the courses and

in defining the pedagogical methodology. The principle of good practice exchange and Peer learning will also be adopted.

The teaching methods will largely recline on student directed learning and – considering the targeted composition of the student population consisting of candidates who already acquired extensive professional experience – will be based on peer-to-peer learning, including the application of benchmarking and exchange of best practices.

These principles will be put forward from the start of the course and have been applied in creating the course materials and and course activities in defining the pedagogical methods.

Teaching methods:	lectures, assignments and team-work
Practice:	permanent evaluation of students' work outcomes, students' atttudes and behaviour
Examination methods:	students' presentations of assignment outcomes, written exams.

STUDY LOAD

1 ECTS credit = 25 hours of study load;
6 ECTS x 25 hours = 150 hours

Study load breakdown

Study load (in hours) attributed to theoretical lectures, practical classes, self-conducted learning, case studies and examination

Lectures	30	hours
Practice	31	hours
Case studies	10	hours
Reworking lectures & Self-directed learning	75	hours
Exams	4	hours
Total	**150**	**hours**

1 hour Lecture = 2 hours Reworking lectures & Self-directed learning
1 hour Case study = 1,5 hours Reworking lectures & Self-directed learning
1 hour Practice = 0 **hours** Self-directed learning

COURSE PLANNING

Activities	Weeks														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
	Course contents														
	1	2	3	4	5	6	6	7	8-10	11-13	14	15	15		
	Trainees workload in hours														All
Lectures	3	3	3	3	3	3	3	3	3	3					30
Practice		3	3	3	3	3	3	3	3	3	4				31
Case studies	-	-	-	-	-	-	-	-	-		2	4	4		10
Reworking lectures & Self-directed learning	6	6	6	6	6	6	6	6	6	6	3	6	6		75
Exams (covers previous 2 weeks of course content)	-		1			1			1						3
Final exam														1	1
Total	**9**	**12**	**13**	**12**	**12**	**13**	**12**	**12**	**13**	**12**	**9**	**10**	**10**	**1**	**150**