COURSE DESCRIPTION CARD - SYLLABUS

Course name
Recycling [S1ZiIP2>REC]

Course

Field of study
Management and Production Engineering

Year/Semester
2/4

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
15

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

2,00

Coordinators

Lecturers

Prerequisites

Basic knowledge in field of materials technology, chemistry, and management (both metal and non- metal-plastics).

Course objective

Learning basic problems related to waste management and their importance for sustainable civilization development.

Course-related learning outcomes

Knowledge:
Allowing identification of waste regarding materials for their further processing (recycling). Allowing identification of relations between manufacturing processes and environment (places of forming the waste). Allowing indication of actions limiting quantities of wastes in production processes used in mechanical engineering.

Skills:
Organization of segregation of industrial waste (metal and plastics). Conducting recycling processes for waste of metals and plastics. Critical evaluation of technical and manufacturing process activities on the environment; can propose actions (processes) reducing quantities of wastes formed during production.

Self-education in field of recycling (knowledge of processes and laws).

Social competences:
Awareness of influence of manufacturing processes in mechanical engineering on natural environment. Awareness of necessity of cooperation between specialists of different fields. Can think and act in an initiative manner. Understands a need of lifetime education.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: Written a test (20 questions), Assignment of grades to percentage ranges of results: <90-100> very good; <80-90) good plus; <70-80) good; <60-70) satisfactory plus; <50-60) satisfactory; <0-50) unsatisfactory.
Laboratory: Attendance to all classes. Positive assessments from raports and answers for written questions asked by a teacher.

Programme content

Lecture: World consumption of materials and energy. Resources of raw materials. Primary and secondary, renewable and non-renewable raw materials. Waste and environmental protection. Administrative and law conditioning of waste management. Classification of waste. Hazardous waste. After-production and after-use waste. Reclaiming and recycling of materials. Recycling of metal and non-metal materials (plastics, paper). Ecological aspects of recycling. Logistical problems in recycling processes. Techniques of recycling of metals, plastics, rubber, etc. Preparation of materials (waste) for manufacturing processes. Course of processing processes and their effects. Studies of polymer regranulated and metal.
Laboratory: Systems of waste segregation. Classification and segregation of metals waste, alloys and plastics. Examples of processing waste out of selected plastics.Processing complex waste on a selected example. Re-melting of metal scrap and plastics reprocessing.

Course topics

Lecture Plastics Recycling (7.5 hours):
1. Characteristics of plastics in terms of recycling.
2. Circular economy of plastics.
3. Analysis of recovery and recycling processes of polymeric plastics (chemical recycling, mechanical recycling, energy recovery).
4. Techniques of sorting and separation of polymeric materials.
5. Example lines for mechanical recycling of waste plastics.
6. Industrial technologies for improving the quality of regranulates.
Lecture Metal Recycling (7.5 hours):
1. Definitions of metal waste and recycling.
2. Metal waste management and characteristics of the waste catalo.g
3. Metal waste flow in the parts manufacturing process.
4. Metal waste collection methods.
5. Metal waste processing methods (shredding, classification, sorting, compaction).
6. Recycling of steels and cast irons (classification of steel and cast iron scrap, the process of making steel from scrap).
7. Recycling of aluminum and its alloys (classification of aluminum alloys, sorting, thermal stripping, fine and coarse scrap melting furnaces, refining, integrated melting plant, can recycling, can melting line).
8. Recycling of copper and its alloys (classification of copper alloys, copper-bearing materials, processing of waste electronic and electrical equipment, cable recycling).
Plastics Recycling Labs (7.5 hours):
1. Assessment of granulometric characteristics of recycled materials.
2. Evaluation of processing properties of mechanical recycling products.
3. Plastics identification technologies in the aspect of waste sorting.
4. Flotation and electrostatic separation of mixed plastics.
Laboratories Recycling of metals (7.5 hours)
1. Classification of scrap metals by size, origin, chemical composition, etc.
2. Scrap sorting methods used in metal recyclables purchasing.

3. Melting of thin-walled scrap, refining of aluminum alloys.
4. Assessment of metallurgical quality of samples cast from aluminum scrap.

Teaching methods

Lecture: multimedia presentation. Laboratory exercises: performing exercises, discussion, team work.

Bibliography

Basic:
1. Czarnecka-Komorowska D., Przetwórstwo i recykling materiałów i kompozytów polimerowych w obiegu zamkniętym, Wydawnictwo Politechniki Poznańskiej, Poznań 2023.
2. Tim A. Osswald Natalie Rudolph, Polymer Rheology Fundamentals and Applications, Hanser Publishers, Munich 2015. Book ISBN978-1-56990-517-3.
3. Mark E. Schlesinger, Aluminum Recycling, Second Edition, CRC Press 2013.
4. Bilitewski B. i inni, Podręcznik gospodarki odpadami, Wyd. Seidel-Przywecki W-wa 2003.
5. Kozłowski M., Plastics Recycling in Europe, Wyd. Politechniki Wrocławskiej 2006.
6. Wilczyński K. Reologia w przetwórstwie tworzyw sztucznych, Wyd. Naukowo-Techniczne, W-wa 2001.
7. Ulewicz M., Procesy odzysku i recyklingu metali nieżelaznych i stali, Wyd. Politechniki Częstochowskiej 2015. ISBN 978-83-7193-636-4.
8. Ulewicz M., Siwka J., Procesy odzysku i recyklingu wybranych materiałów, Wyd. Wydziału Inż. Proc., Mat. i Fizyki Stosowanej Politechniki Częstochowskiej, Częstochowa 2010.

Additional:
1. Hong Hocheng, Mital Chakankar, Umesh Jadhavt, 1st Edition, Biohydrometallurgical Recycling of Metals from Industrial Wastes, CRC Press 2018.
2. Brandrup, J., Bittner, M., Menges, G., and Michaeli, W. (1996) Recycling and recovery of plastics, Carl Hanser Verlag, Germany.
3. Letcher T., Plastic Waste and Recycling: Environmental Impact, Societal Issues, Prevention, and Solutions, 1st Edition, Academic Press 2020.
4. .Pascoe, R. D. (2000) Sorting of Waste Plastic for Recycling, Rapra Review Reports, 11, 4.
5. Oprzędkiewicz J., Technologie i systemy recyklingu samochodów, WNT Warszawa 2003
6. Praca zbiorowa pod red. Jerzego J. Sobczaka, Odlewnictwo Współczesne. Poradnik Odlewnika, Wyd. Stowarzyszenia Technicznego Odlewników Polskich, Tom 1. Materiały, Kraków 2013. ISBN: 878-83-904306-9-0

Breakdown of average student's workload

	Hours	ECTS
Total workload	50	2,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	20	1,00