module title: **THEORY OF WELDING PROCESSES**		
field of study: **Mechanical Engineering**	type of study: **full-time**	course code: **S6_3-11**
course: **Modelling & Simulation in Mechanics**	degree: **Master (MSc)**	year: **I** semester: **II**
type of classes: **lecture, classes, laboratory**	hours per week: **2L, 1C, 1Lab**	No of ECTS credits: **5**

MODULE DESCRIPTION

TARGETS

T1. Provide theory of the phenomena occurring in the welding arc and basics of the physio-chemical bonding process.
T2. Provide theory of construction of the welded joint and the phenomena accompanying the flow of heat during the welding process.
T3. Acquisition by students practical skills weldability assessment and selection of basic materials and additives for various bonding methods.
T4. Acquisition by students practical skills of calculation of heat flow, stress and welding distortions of welded joints.

PREREQUISITES & ADDITIONAL REQUIREMENTS

R1. Fundamentals of materials science.
R2. Fundamental of basic welding techniques.
R3. Ability to perform mathematical operations to solve given tasks.
R4. Capability of using source literature.
R5. Capability of individual work and collaboration in a group.
R6. Data analysis and presentation of results.

LEARNING OUTCOMES

LO1. Knowledge concerning phenomena in the welding arc.
LO2. Knowledge on thermal cycle of welding.
LO3. Ability to calculate parameters of thermal cycle.
LO4. Knowledge on metallurgical aspects of welding.
LO5. Knowledge on construction of the welded joint.
LO6. Knowledge on stress and distortion in the welded joints.
LO7. Ability to predict the value of stress and welding deformation and knowledge on method of their minimizing.

MODULE CONTENT

LECTURE	hours
L1-2 - Basics - classification and types of welding processes.	**2**
L3-6 - Characteristics of the welding arc and the phenomena occurring in the welding arc.	**4**
L7-8 – The types of welding sources used in welding.	**2**
L9-11 - Basic issues related to the flow of heat in welding.	**3**
L12-13 - Welding heat cycles – types and main parameters.	**2**
L14-17 - Metallurgical phenomena occurring during the welding process.	**4**
L18 -19 – Construction of welded joint – changes in the heat affected zone.	**2**
L20-21 - The formation and the distribution of stresses in the welded joint.	**2**
L22-23- Characteristics of welding distortions.	**2**
L24-27 - Types and causes of cracks in welded joints.	**4**
L28-30 - The concept of weldability, and methods of evaluation.	**3**

CLASSES	hours
Cla 1-5 - Calculation of the characteristic values of the thermal cycle of welding	**5**
Cla 6-9 – Calculation of the stress and welding distortion in welding joints.	**4**
Cla 10-11 - Analytical methods for the evaluation of weldability	**2**
Cla 12-13 – Assessment of propensity to crack in welded joints.	**2**
CLa 14-15 – Calculation of preheating temperature for welded joints.	**2**

LABORATORY	hours
Lab 1-2 – Analysis of the types of material transport in welding arc.	**2**
Lab 3 - The evaluation of the arc blow effect	**1**
Lab 4 - Arc flexibility test	**1**
Lab 5-6 - Survey the effect of welding on the type and size of the welding distortion.	**2**
Lab 7-9 - Study of the effect of welding heat input on the hardness of the HAZ	**3**
Lab 10-11 - Experimental investigation of ability to brazing and soldering of different materials.	**2**
Lab 12-13 - Analysis of heating and cooling cycle of the basic materials used in welding	**2**
Lab 14-15 - Experimental analysis of processes of friction and electric resistance welding.	**2**

TEACHING TOOLS

1 - lecture with the use of multimedia presentations
2 - experimental stands equipped with measuring instrumentation
3 - computer laboratory, blackboard, calculator
4 - instructions to laboratory exercises

SOURCE LITERATURE

1. Grong Ø.: Metallurgical modelling of welding. Michigan Institute of Materials, 1997
2. Granjon H.: Fundamentals of welding metallurgy. Abington Publishing ,1999
3. Hongyang Zang, Senkara J.: Resistance welding: Fundamentals and applications. Taylor&Francis Group, 2012
4. Feng Z.: Processes and mechanism of welding residual stress and distortion. Woodhead Publishing, 2005
5. Radaj D.: Heat Effects of Welding: Temperature Field, Residual Stress. Berlin Springer-Verlag, 1992
6. Radaj D.: Welding residual stresses and distortion : Calculation and measurement. Dusseldorf: Verlag feur Schweissen und verwandte Verfahren DVS-Verlag GmbH, 2003

TEACHERS

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