UNICUSANO
ROME

Code: ING-IND/15 **Credits: 6**
Course: Industrial Technical Drawing
Main language of instruction: Italian
Other language of instruction: English

Teaching Staff

Head instructor
Prof. Stefano PAPA – Stefano.papa@unicusano.it

Introduction

1. *Objective of the course:*

The course aims to provide knowledge of the technical language and techniques of Industrial Technical Drawing, analyzing in particular the main regulations of the sector, focusing on the practical point of view, and examining the main machine elements. In particular, the approaches useful for defining a unique correspondence between what is represented and the characteristics of the object will be highlighted through the satisfaction of a series of standards of representation, agreed between the various national unification bodies, which are part of the global organization ISO (International Organization for Standardization).

Objectives

2. *Course Structure:*

The Course deals with graphic representation techniques of machine components with a special focus on Monge's method of projections. Furthermore, the Course aims to introduce the students to the basic engineering language as well as to the ability of shape imagination and visualization in the space. Starting from the knowledge of the basic shapes for machine components, the students acquire the ability to interpret the construction drawing of the main machine components and their assemblies. Thus, the Course allows the student to know the machine elements, to make a dimensioned drawing, to correctly read and interpret basic industrial drawings according to the international standards, in conjunction with a critical analysis of shapes and functions of the main machine element

Competencies:

A. Knowledge and understanding:

The student must demonstrate that he/she has achieved an adequate knowledge of industrial technical drawing with a special emphasis on the following features:

- Knowledge of technical drawing as graphic language for the communication of technical information at the international level;
- Knowledge of the basic methods of freehand drawing;
- Basic knowledge of functional analysis of mechanical assemblies;
- To distinguish the geometric characteristics of the product and their relationship with simple processing cycles employed for the product development;
- Definition of functioning/operating principles, construction aspects and performance requirements of the basic mechanical components.

B. Applying knowledge and understanding:

At the end of the Course the student must demonstrate that he/she has acquired notions of industrial technical drawing and, in particular, the following abilities:

- Interpretation of part and assembly drawings, and representation of simple machines;
- Knowledge and planning of tolerance of mechanical system components;
- Understanding of the effect of the manufacturing errors on the functional characteristics of a mechanical assembly and of the surface finishing on the mechanical strength of metallic materials;
- Development of assemblies of simple groups and construction drawings, according to the fabrication methodologies;
- Correct use of unified elements;
- Understanding of design and verification methodologies and technical reference standards.

C. Making judgements:

At the end of the course, the student will be able to read, interpret and represent technical parts or assemblies on industrial components.

D. Communication skills:

The technical language, needed to interact with other experts in the discipline and with decision makers inside public administrations and companies in the sector, will be gained.

E. Learning skills:

The knowledge and the key methodological tools that will be useful in subsequent advanced professional training in the areas of technical drawing, will be provided.

Syllabus

3. *Programme of the course:*

1. The first part of the Course consists of elements of descriptive geometry and introduces the students to the technical standards and regulation (UNI, ISO) concerning orthogonal projections, sections and dimensioning systems. Function and role of technical drawing. Projective and descriptive geometry: Monge's projections and selection of principal views. The surface intersection problem: a brief outline. Standardisation criteria and standards for technical drawing.
Standardised systems for the representation of sections of solids. Projected sections – parallel planes and incident planes, partial sections, revolved sections. Half-views and half-sections. Conventional indications for cutting plane line. Common errors in the representation of sections.
Standardised systems for graphic representations and dimensioning systems for solids. Geometric dimensioning: size and location dimensions. Assembly dimensions and auxiliary dimensions. Dimensioning systems (functional, technological and for inspection). Functional conditions for assembly: axial constraints, radial constraints, accessibility, assemblability and disassemblability of parts. Selection of dimensions according to functional conditions. Technological dimensioning according to machining, casting and moulding technologies. Selection of processing dimensions according to the processing cycle for axisymmetric elements. Threads: conventional representation and technological dimensions. Representation and dimensioning of chamfers, rounds, conicity, tapering, inclined surfaces, grooves for internal and external threads. Standardisation and unification.

2. The second part of the Course deals with surface finishing and dimensional tolerances. Accordingly, this part aims to introduce the students to the main functional and construction problems generally present in the assemblies as well as to the international standards. Macro-geometric errors due to manufacturing process. Definition of design or functional tolerances and manufacturing tolerances; natural tolerances and productivity. ISO tolerance systems; Criteria for the selection of dimensional tolerances according to functional conditions, and recommended fits. Definition of general tolerances. Limit dimensions, deviations and their calculation. International tolerance grades and fundamental deviations. Graphic representation for deviations. Minimum and maximum material conditions.
Microgeometric errors due to manufacturing process. Surface finishing and roughness parameters. Evaluation of the average roughness. Mean profile: formula and demonstration. Integral and discrete roughness. Selection of roughness and typical values in the case of simple machine elements. Relationship between

roughness and tolerances. Tolerance limit values related to specific values of average roughness.

3. The third part of the Course is devoted to the study concerning the representation of the main connection parts for mechanical systems. The study of assemblies consisting of several machine components allows to analyse the contribution that each part makes to the functioning of the machine or the mechanical system. Permanent and removable fasteners. Threads: Metric, Whitworth, Gas, Trapezoidal and Buttress. Designs of screws and nuts. Threads for fastener screws and manoeuvring screws. Designation of threaded fasteners: cap screw, bolt and studs. Functioning of screw-nut couple; actions of threaded parts and reactions of connected parts; mechanical stress analysis for screw stem and failure conditions for screw; the technical problem of spontaneous unscrewing; devices to avoid unscrewing. Non-threaded removable fasteners - (tapered) keys and parallel keys; functioning principle – friction and mechanical obstacle; typical shapes for parallel keys (A, B and C); Woodruff keys; typical shapes for (tapered) keys (A, B and C), gib-head key and tangent key; saddle and hollow keys; technical problems and selection according to the several typologies and functioning conditions; selection of parameters (width, height and length) through technical standards and dimensioning; characteristic features of splined shafts. Pins, split pins, elastic rings (e.g., Seeger-ring). Spring: typology and typical applications. Representation elements of permanent fasteners: definition and representation of hot and cold riveted joints, morphological features and placement on the parts to be connected. Representation of welded joints and welding symbols. Analysis of mechanical assemblies. Motion transmission systems. Rigid and elastic joints, universal joints; representation and functioning of machine elements such as transmission shafts, sliding bearings, pulleys, belts, connecting rod, crank, crankshafts, gears and rolling bearings.

Evaluation system and criteria

The examination consists of the graphical representation of a part from an assembly in section, completed with dimensions and tolerancing.

In addition, two e-tivities, consisting of a graphical representation and a tolerance definition, are compulsory. These need to be sent to the instructor in advance of the examination. The e-tivities counts a total of 5 out of 30 marks.

Bibliography and resources

4. *Materials to consult*

Notes written by the instructor are available in Italian (part of the notes are also available in English).

5. *Recommended bibliography*

Suggested readings are:

Chirone E. e Tornincasa S., Disegno Tecnico Industriale, two volumes, Il Capitello Ed. 2018-19.
Carfagni M. et al., Esercitazioni di Disegno Meccanico, Zanichelli, 2020, II Ed.
Barone S. et al., Disegno Tecnico Industriale, Città Studi Ed.,2020.
Caligaris et al., Manuale di Meccanica, HOEPLI Ed.
Baldassini e Fiorineschi, Vademecum per disegnatori e tecnici, HOEPLI Ed.