NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF GEOLOGICAL, MINING AND METALLURGICAL ENGINEERING
METALLURGICAL ENGINEERING PROGRAM

ME420 – MANUFACTURING ENGINEERING

I. GENERAL INFORMATION

CODE	**:**	ME420 Manufacturing Engineering
SEMESTER	**:**	7
CREDITS	**:**	3
HOURS PER WEEK	**:**	5 (Theory – Practice)
PREREQUISITES	**:**	ME322 Solidification, ME323 Materials Science and Engineering
CONDITION	**:**	Compulsory

II. COURSE DESCRIPTION

Welding, oxyacetylene welding, electric welding, MIG/MAG welding, TIG (Tungsten Inert Gas) welding and its applications. The lathe. Operation systems, cutting tools, turning procedures, cutting speed, forces, powers and turning processing time. Milling machine. Operation system, types of milling, types of cutting tools, polygonal pieces milling, gears, forces and powers in the milling, milling processing times. The drill. Operation system, types of drill bits, pieces machining using the drill. Drill processing times. This course will be carried out based on the machining theory, workshops will involve the use of real pieces and labs will, in turn, involve research topics. Make students identify, and handle equipments and machine tools, with fieldtrips to production enterprises and industrial training centers.

III. COURSE OUTCOMES

1. Know the uses and parts of different arc welding equipments, MIG/MAG systems, TIG system and oxyacetylene welding.
2. Explain characteristics and most important accessories that made up the different equipments.
3. Assess capacities, restrictions and limitations of these equipments for small and big operations.
4. Assess energy needs and costs in general.
5. Know the different machines tools universally used in the mechanized conformation of industrial products by milling and advanced mechanical forming.
6. Know about machine tools operated by computerized numeric control.

IV. LEARNING UNITS

1. WELDING EQUIPMENT / 12 HOURS

General ideas / Introduction / Types of welding / Fusion welding / Solid state welding / Oxyacetylene welding: equipment, combustible gases, flux, types of flames. Electric welding: operation principle, electric arc, polarity, welding name, joints and positions, symbology and welding representations, safety. MIG/MAG welding: equipment and process scheme, metallic transfer, protective gases and applications, wire names. TIG welding: equipment and process scheme, electrode identification and selection. Advantages and disadvantages of MIG/MAG and TIG welding modes.

2. LATHES / 16 HOURS

Lathes: general. Main components of a lathe. Advanced mechanical forming with milling. Revolution-shaped pieces. Cutting tools materials. Cutting tools fastening. Cutting tolls position. Piece and tool movements. Cutting tool angles. Types of swarf. Turning procedures. Mechanism of the main slide. Cutting speed and RPM calculation. Types of lathe: parallel, air horizontal spindle, vertical, copier. Types of lathe tools: swarf section. Calculation of forces and cutting power in turning. Power absorbed during the turning. Turning processing time. Semi-automatic and automatic lathe. Conicity. Cone measurement. Conic turning procedures. Characteristic of thread. Application of threads with several fillets. Standardized thread. Thread names. Mechanisms and gear train for threading in the lathe.

3. MILLING MACHINE / 20 HOURS

Milling machine. General. Main components of the milling machine. Types of milling. Mill fastening. Mill RPM calculation. Movements in the milling machine. Pieces fastening. Straight and parallel milling. Milling accessories. Dividing head. Types of divisions in the dividing head. Milling angles. Types of mills. Operation in the milling machine. Types of milling machines. Calculation of the main time in the milling. Calculation of cutting forces and power during the milling. Torsional moment. Absorbed power in milling. Gears. General. Toothed wheel shapes. Tooth profile. Spur gear. Milling of toothed wheels tooth by tooth and continuous procedure. Magnitudes. Rack. Magnitudes and calculation of rack. Helical gear. Magnitudes and calculation of helical gear. Materials for toothed wheels.

4. DRILL / 8 HOURS

Dill. General. Operation mechanism. Movements in the drill. Types of drills. Types of drill bits. Drill bit angle. Number of revolutions of the drill bit. Multiple drill. Material of drilling tools. Operation sin the drill. Main time in the drill.

V. LABORATORIES AND PRACTICAL EXPERIENCES

Lab 1: Spot, plasma, submerged arc, induction, ultrasonic and fusion welding.
Lab 2: Laser welding, turret, vertical and CNC lathes, Machining center.
Lab 3: Flat and cylindrical rectifier, radial drill.
Lab 4: Angle grinders, saws, planer, tools and fluids for cutting.
Lab 5: Shaper, profiling machine, shears, jointing sawing machine, hydraulic press.

VI. METHODOLOGY

Active methodology will be used to favor students' learning. Students' active participation through oral interventions solution to problems and exercises. Case analysis and discussion in groups.

VII. EVALUATION FORMULA

The average grade PF is calculated as follows:

PF = (PL + PT + EP + EF)/4

EP: Mid-Term Exam EF: Final Exam
PT: Workshop average TL: Labs average

VIII. BIBLIOGRAPHY

1. **MARKS**
   Mechanical Engineer's Handbook (Spanish)
   Mc Graw Hill Editorial
2. **HODSON**
   Industrial Engineer's handbook (Spanish)
   Mc Graw Hill Editorial
3. **KRAR CHECK**
   Technology of Machine Tools (Spanish)
   Alfaomega Editorial, 5th Edition

IX. COURSE CONTRIBUTIONS TO STUDENT OUTCOMES ATTAINMENT

Course contributions to Student Outcomes are shown in the following table:

Level 1: Know
Level 2: Comprehend, calculate
Level 3: Model, apply, solve
Level 4: Apply at advanced level, design. Achievement of Student Outcome

Outcome	Contribution
1. Engineering Design Design and integrate metallurgical systems and components satisfying requirements and needs as well as given technical, economic, social and legal constraints and limitations.	2
2. Problem solving Identify, formulate and solve engineering problems properly using the methods, techniques and tools of metallurgical engineering.	3
3. Sciences Application Apply the knowledge and skills of mathematics, sciences and engineering to solve metallurgical engineering problems.	3
4. Experimentation and Testing Conceive and conduct experiments and tests, analyze data and interpret results.	2
5. Modern Engineering Practice Use and apply techniques, methods and tools of modern engineering necessary for the practice of metallurgical engineering.	3
6. Engineering Impact Understand the impact of metallurgical engineering solutions on people and society in local and global contexts.	3
7. Project Management Determine the budgets, schedules and feasibility of engineering projects, and participate in its management for the attainment of goals.	2
8. Environmental Appraisal Take into account the importance of preserving and improving the environment in the development of their personal and professional activities.	3
9. Lifelong Learning Recognize the need to keep their knowledge and skills up-to-date according to advances of metallurgical engineering and engage in lifelong learning.	3
10. Contemporary Issues Know and analyze relevant contemporary issues in local, national and global contexts.	3
11. Ethics and Professional Responsibility Evaluate their decisions and actions from a moral perspective and assume responsibility for the executed projects.	3
12. Communication Communicate clearly and effectively in oral, written and graphical formats, interacting with different types of audiences.	3
13. Teamworking Appraise the importance of teamworking and participate actively and effectively in multidisciplinary teams.	3