



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

METALLURGICAL ENGINEERING PROGRAM

ME322 SOLIDIFICATION

I. GENERAL INFORMATION

CODE	: ME322 Solidification
SEMESTER	: 6
CREDITS	: 4
HOURS PER WEEK	: 6 (Theory, Practice, Laboratory)
PREREQUISITES	: ME311 Metallurgic Physics-Chemistry
CONDITION	: Compulsory
DEPARTMENT	: Metallurgical Engineering

II. LEARNING UNITS

1. HEAT TRANSFER IN SOLIDIFICATION

Heat transfer mechanisms. Fourier law and thermal conductivity. Fusion and growing of a simple metal. Solidification of pieces and ingots. Sand models and metallic molds. Continuous casting.

2. METAL SOLIDIFICATION

Nucleation: homogeneous, heterogeneous and dynamic. Growing: pure metals and alloys. Overcooling. Central feed resistance CFR. Variables affecting solidification speed. Phenomena produced during solidification.

3. TENSION-DEFORMATION RELATIONS DURING SOLIDIFICATION

Tension-deformation relations as function of temperature. In-heat cracking. Cracking, residual stress and stress relief. Measurement of residual stress. Relationship between in-heat cracking and residual stress.

4. METAL FLUIDITY

Measurement of fluidity. Fluidity spiral. Fluidity typical curves. Effect of chemical composition. Application of fluidity data to casting problems.

5. GASES IN METALS

Gases in metals: hydrogen and nitrogen. Complex gases in steel. Complex gases in copper. Vacuum casting. Inclusions and inoculations.

6. RISER DESIGN AND FEEDING SYSTEM DESIGN

Contractions in castings. Riser design methods: M.Caine, M.Bishop, M.Modules. Types of risers. Directional solidification. Methods for solidification control. Design of feeding system. Continuity law / Bernoulli equation. Types of feeding systems: vertical, horizontal, from bottom. Sources.

Casting channel. Effective height of filling. Pressurized systems / Non-pressurized systems.
Defects in castings.

III. LABORATORY

Laboratory 1. Fineness index of casting sands

Laboratory 2. Analysis of different types of clays (sand, clay, water)

Laboratory 3. Solidification testing (fusion and casting of zinc pieces in different molds)

Laboratory 4. Fluidity testing (molding, fusion and aluminum casting)

Laboratory 5. Riser design and feeder design for a copper or aluminum piece.