



UG program in
Metallurgical and Materials Engineering
Indian Institute of Technology Patna

Content of Laboratory Courses

**MM203 Introduction to Minerals Processing and Raw Materials
(0-0-3) 3 credit**

Crushing of ore: Jaw crushers, grinding mills, reduction ratio, Rittinger's law of crushing, industrial particle size control.

Size distribution of ores: Sieve analysis, mesh number and size, ASTM standard, sieve shaker, vibratory shaker, ball milling.

Particulate separation: Gravity separation, solid liquid separation, froth floatation process (phosphate and copper), magnetic separation, electrostatic separation.

Beneficiation of ores: coal and ores of copper, zinc, iron

Text Books:

1. Principles of Mineral Dressing: A.M. Gaudin, Tata McGraw Hill, 1980.
2. Extraction of Non-ferrous Metals: H.S. Ray and K.P. Abraham, East West Press, 2006.
3. Mineral Processing, M.R. Pryor, Springer, 1965.

**MM210 Metallography and Heat Treatment laboratory
(0-0-3) 3 credit**

Metallographic sample preparation: Sample cutting, mounting, grinding, dry and wet polishing, grit sizes.

Etching: chemical etching, thermal etching, electropolishing, conductive coating on ceramics.

Quantification of microstructures: ASTM grain size number, calculating grain size, mean intercept method, Jefferies method, determining volume fraction of phases

Equipment: Introduction to furnaces, bath and quenching media.

Heat treatment of steel: Heat treatment of plain carbon steel and alloy steel: annealing, normalizing, quenching, tempering. Microstructure evolution. Effect of cooling media, hardenability measurement.

Recrystallization and annealing: recrystallization in copper and aluminium alloys, microstructure development.

Text books:

1. The Principles of Metallographic Laboratory Practice: George L. Khel, McGraw Hill, 1949
2. Physical Metallurgy: V. Raghvan, 3rd Ed., Prentice Hall India, 2015.
3. Steel and its Heat Treatment: K.-E. Thelning, 2nd Ed., Butterworth-Heinemann, Elsevier, 1984.
4. Heat Treatment: Principles and Techniques: T.V. Rajan, C.P. Sharma, Ashok Sharma, 2nd Ed., Prentice Hall India, 2010.
5. Heat Treatment of Metals: Vijendra Singh, Standard Publishers Distributors, 2009.

MM301 Techniques of Materials Characterization (0-0-2) 2 credit

Practical aspects of X-ray diffraction analysis will be emphasized; hands-on experience in qualitative and quantitative analysis techniques, use of electronic databases, and phase analysis using XRD data.

Powder characterization using XRD, SEM and BET, gas pycnometer, hands-on experience on the applications of metallography and optical microscopy, phase analysis using microscopic information, hands-on experience in the area of microstructures of metal, ceramic and polymer materials using optical microscopy and SEM.

Thermal properties of materials, identification of materials based on their TG, DSC, DMA characteristic responses

Standard laboratory practice including safety, report writing, and error analysis are also emphasized.

Text Books:

1. Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, Yang Leng; 2nd Ed., Wiley, 2013.
 2. Scanning Electron Microscopy and X-Ray Microanalysis: Joseph Goldstein, Eric Lifshin, Charles E. Lyman, David C. Joy and Patrick Echlin, 3rd Ed., Springer, 2003.
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MM311 Materials Processing Lab I
(0-0-3) 3 credit

Mold making: Mold cavity, pattern making, gating system and riser design.

Ingot casting: Casting design, Melting furnaces, die casting of metal and alloy, shape casting, moiling, refining and pouring.

Defects in castings: Physical inspection, hot tear cracks, pores, voids.

Solidification microstructures: Dendritic microstructure, grain structure, homogenization, alloying element addition during casting.

Additive manufacturing of polymers:

Solidification of glass: preparation of soda lime silica glass, effect of coloring agents, preparation of glass-ceramics.

Text Books:

1. Fundamentals of Metal Casting, Richard Aloysius Flinn, Addison Wesley, 1963
2. Principles of Metal Casting, Richard W. Heine, Carl R. Loper, Philip C. Rosenthal, 2nd Ed., McGraw Hill, 2017
3. Casting Technology and Cast Alloys, A.K. Chakrabarti, Prentice Hall India, 2005

MM312 Materials Processing Lab II
(0-0-3) 3 credit

Metal working: rolling, forging and extrusion of metals. Strain calculations, effect of temperature and friction, microstructure development

Welding: TIG welding, metal cutting, solid state welding. Welding microstructure, Heat affected zone

Ceramic processing: Slurry preparation, slip casting, cold compaction, sintering, microstructure evolution

Polymer processing: extrusion, injection moulding and compression moulding of polymer. Effect of additives and fillers. Effect of processing conditions.

Text Books:

1. Metalworking - Doing it Better: Machining, Welding, Fabricating, Tom Lipton, Industrial Press Inc., 2013
2. Ceramic Processing and Sintering: M.N. Rahaman, Marcel Dekker, 1995
3. Engineering Plastics Handbook: James M. Margolis, McGraw Hill, 2006.

MM314 Mechanical Metallurgy Lab
(0-0-3) 3 credit

Tensile/compression test: Introduction to UTM, tensile and compression test on aluminium, copper, steel and polymer, plotting engineering and true stress strain curves, calculate tensile properties, effect of strain rate, strain rate sensitivity.

Hardness: Micro and macro-hardness of metal, alloy, ceramic and polymer materials, fracture toughness, nanoindentation, determination of elastic modulus, ductility, Jominy hardenability test.

Fracture: fracture surface of metal, ceramic and composites, case study of ductile and brittle fracture.

Fatigue and impact test: Rotary bending fatigue testing on steel and aluminium sample, generation of S-N curve, fatigue limit, Charpy V-notch impact test.

Non-destructive testing: Radiography, ultrasonic testing

Text Books:

1. Mechanical Metallurgy, George E. Dieter, 3rd Ed., McGraw Hill, 2017.
2. Mechanical Behavior of Materials: Thomas H. Courtney, 2nd Ed., Waveland Press, 2000.
3. Mechanical Properties and Working of Metals and Alloys: Amit Bhaduri, Springer, 2018.