Department of Mechanical and Production Engineering
Ahsanullah University of Science and Technology (AUST)

ME 2204: Engineering Materials
Credit Hour: 1.5

General Guidelines:

1. Students shall not be allowed to perform any experiment without apron and shoes.
2. Students must be prepared for the experiment prior to the class.
3. Report of an experiment must be submitted in the next class.
4. Viva for each experiment will be taken on the next day with the report.
5. The report should include the following:
    - Top sheet with necessary information
    - Main objectives
    - Work material/machine/tool/equipment used (with their specifications)
    - Experimental procedures
    - Experimental results and discussions (Experimental setup, Experimental conditions, Data, Graph, calculation etc.)
    - Conclusions
    - Acknowledgements
    - References
6. A quiz will be taken on the experiments at the end of the semester.
7. Marks distribution:

Total Marks		
Report	Attendance and Viva	Quiz
30	30	40

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Course Number: ME 2204

Course Title: Engineering Materials Sessional

Title: Study of different types of cast iron &their properties.

Questions:

1. Draw an Iron- Carbide phase diagram up to 6.67% of carbon.
2. What is the classification of cast iron?
3. A machine part is made that have to take higher tensile strength and must have ductility, which cast iron you should be used. Draw the microstructure of the cast iron in-
    1. Fast cooling
    2. Slow cooling
4. Write the properties of gray cast iron so that it is produced in higher quantities.
5. What is the heat treatment to produce malleable cast iron from white cast iron? Draw the diagram of two types of malleable cast iron.

Q 1: A copper–nickel alloy of composition 70 wt% Ni–30 wt% Cu is slowly heated from a temperature of 1300°C (2370°F).

(a) At what temperature does the first liquid phase form?

(b) What is the composition of this liquid phase?

(c) At what temperature does complete melting of the alloy occur?

(d) What is the composition of the last solid remaining prior to complete melting?

Q 2: Is it possible to have a copper–nickel alloy that, at equilibrium, consists of an α phase of composition 37 wt% Ni–63 wt% Cu, and also a liquid phase of composition 20 wt% Ni–80 wt% Cu? If so, what will be the approximate temperature of the alloy? If this is not possible, explain why.

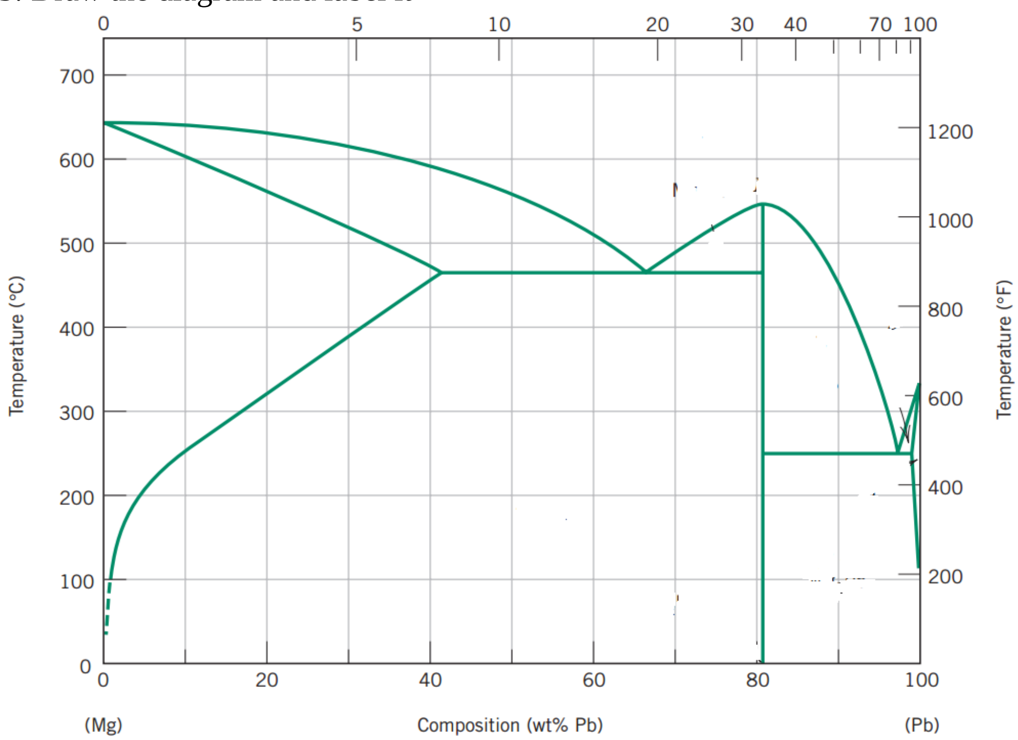
Q 3: For a 35 wt% Ni- 65 wt% Cu alloy at 1250^0c ------

1. What phase(s) is(are) present?
2. What is(are) the composition(s) of the phase?
3. What is (are) phase amount?
4. Draw the microstructure at this phase?

Q 4: For a 40 wt% Sn- 60 wt% Pb alloy at 150^0c ------

1. What phase(s) is(are) present?
2. What is(are) the composition(s) of the phase?
3. What is (are) phase amount?
4. Draw the microstructure at this phase?

Q 5: Draw the diagram and label it-



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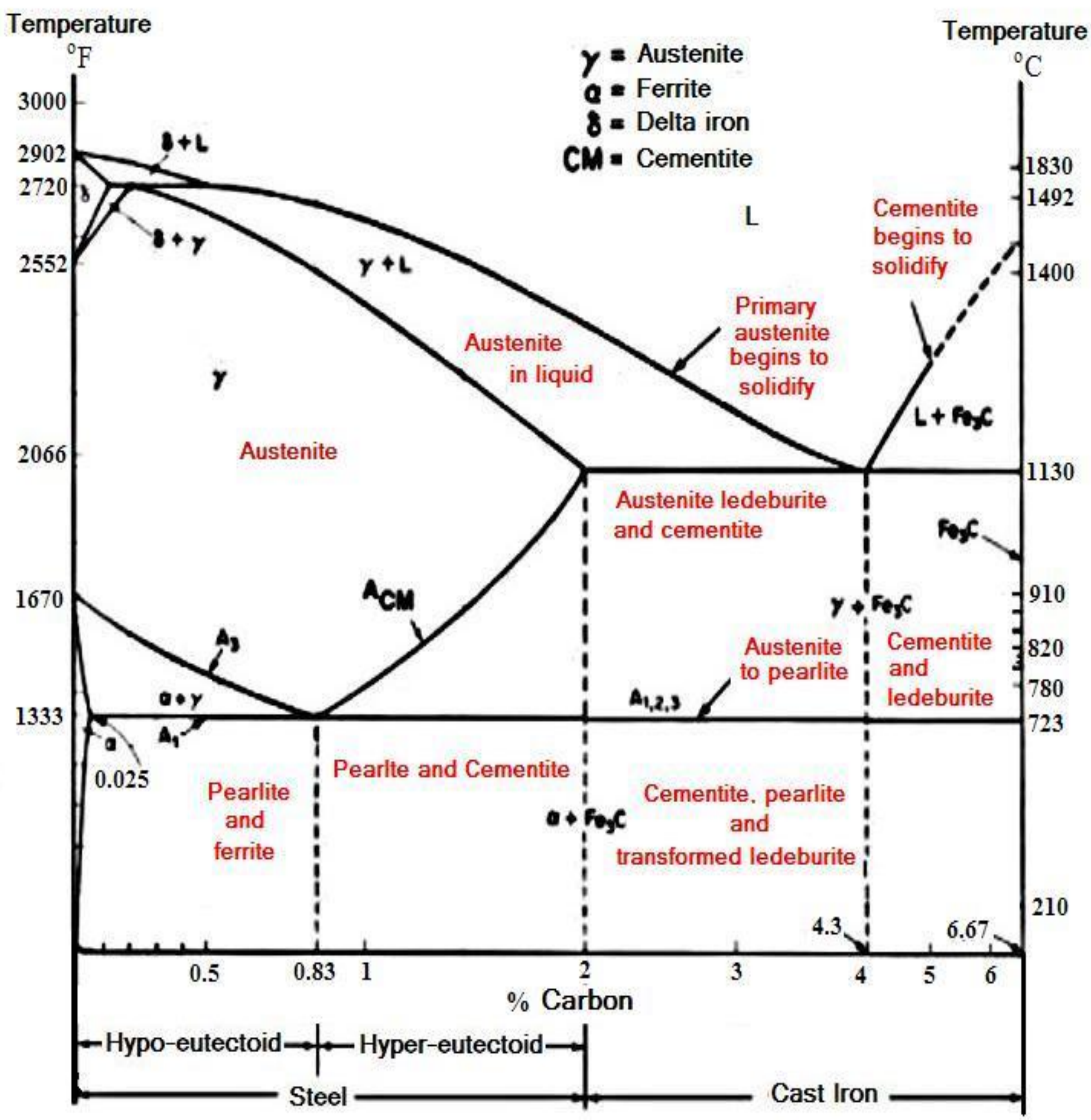

The Iron–Iron Carbide (Fe–Fe3C) Phase Diagram

Questions:

1. What is the distinction between hypoeutectoidand hypereutectoid steels?

2. What is the carbon concentration of an iron–carbon alloy for which the fraction of total ferrite is 0.94?

3. Consider 1.0 kg of austenite containing 1.15 wt% C, cooled to below 723C (1333F).

   (a) What is the proeutectoid phase?

   (b) How many kilograms each of total ferrite and cementite form?

   (c) How many kilograms each of pearlite and the proeutectoid phase form?

   (d) Schematically sketch and label the resulting microstructure.

4. The microstructure of an iron–carbon alloy consists of proeutectoid ferrite and pearlite; the mass fractions of these microconstituents are 0.20 and 0.80, respectively. Determine the concentration of carbon in this alloy.

5. Consider 2.0 kg of a 99.6 wt% Fe–0.4 wt% C alloy that is cooled to a temperature just below the eutectoid.

   (a) How many kilograms of proeutectoid ferrite form?

   (b) How many kilograms of eutectoid ferrite form?

   (c) How many kilograms of cementite form?

6. Is it possible to have an iron–carbon alloy for which the mass fractions of total cementite and pearlite are 0.039 and 0.417, respectively? Why or why not?

7. For a 79.65 wt% Fe-0.35 wt% C alloy at a temperature just below the eutectoid, determine the following:

   (a) The fraction of total ferrite and cementite phases.

   (b) The fractions of the proeutectoid ferrite and pearlite.

   (c) The fraction of eutectoid ferrite.

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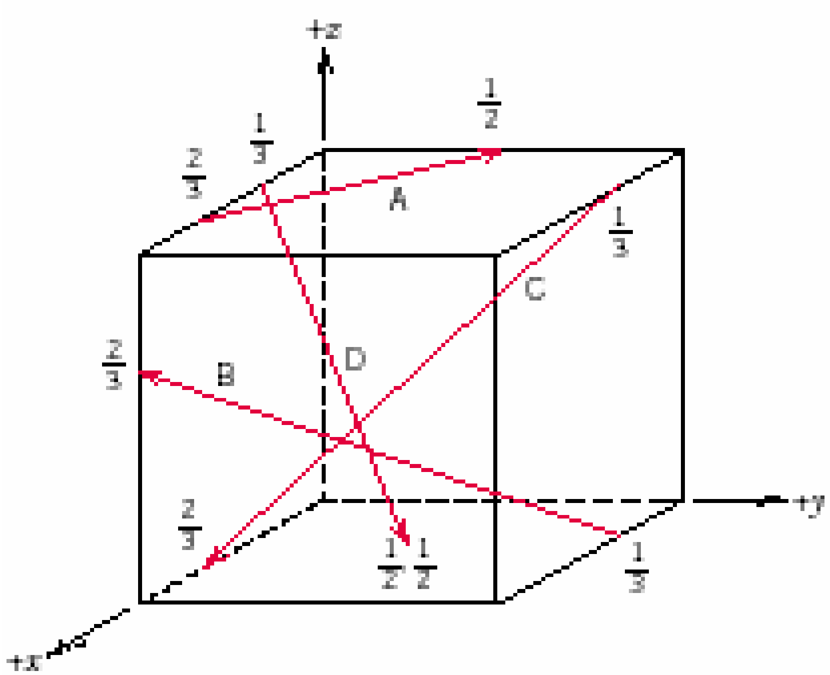
Course Number: ME 2204

Course Title: Engineering Materials Sessional

Experiment No: 04

Name of the Experiment: Calculation of Crystallographic direction and planes for different crystal system.

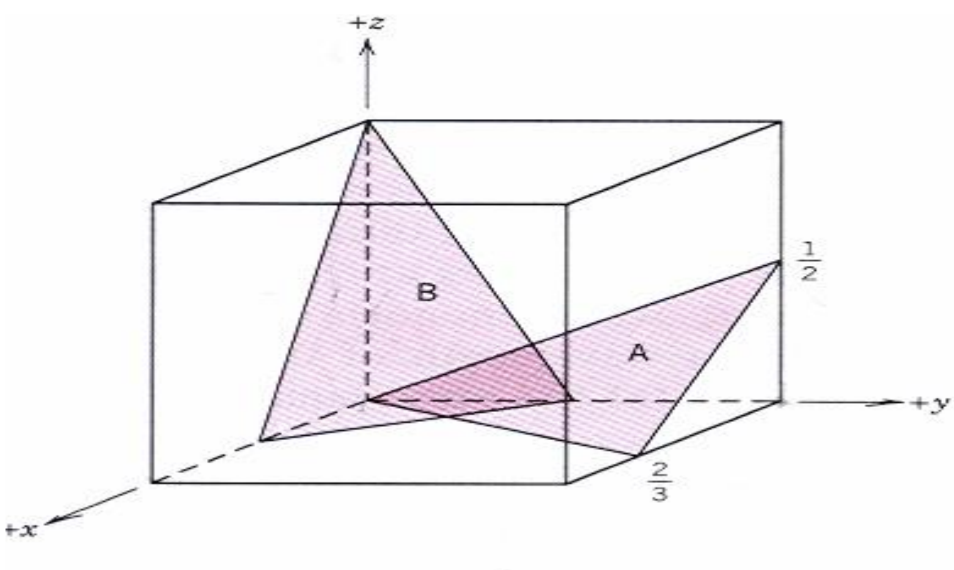
1. Determining the indices of line directions.



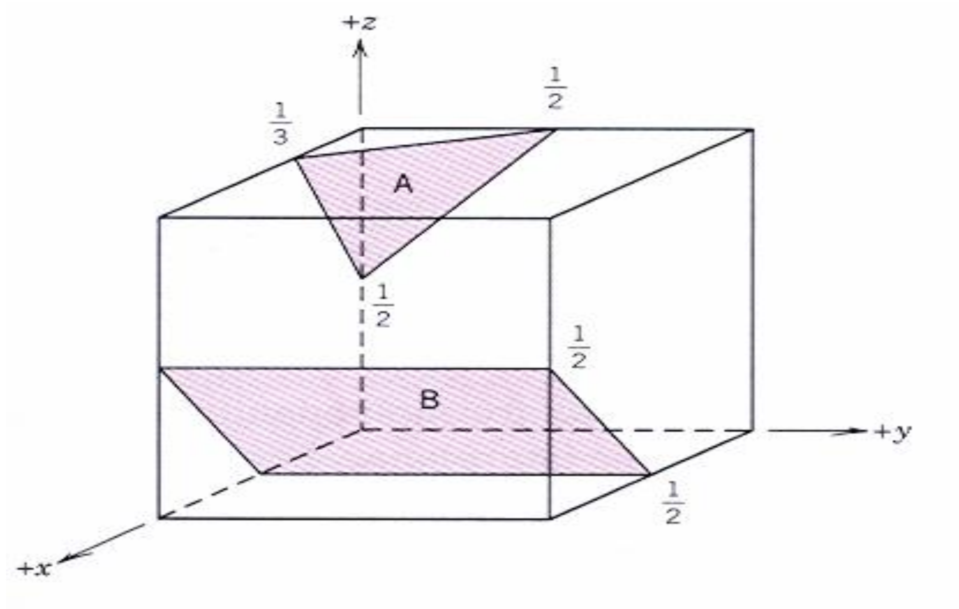
2. Sketch the following direction: **[110], [120], [-1 0 2]**

3. Determine Miller indices of planes A and B:

(a)



(b)



4. Construct planes by Miller indices of planes **(110), (200), (634)**

5. Find the angle between two planes **(111) and (1-1 1)**

6. Calculate Planar density for Simple cubic system of **(100)** plane where lattice parameter **(a=3.03Aº)**

7. Calculate linear density of FCC structure in **[110]** direction where lattice parameter **(a=4.20Aº)**

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ME-2204:Engineering Materials Sessional

Credit Hour: 1:50

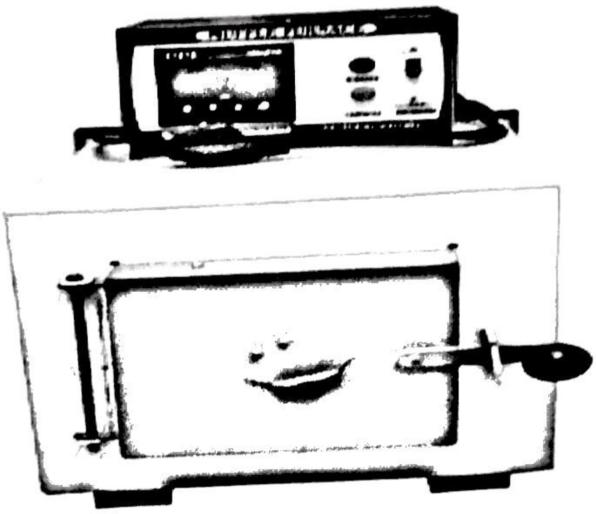
Experiment No: 5

a. Microstudy of Carburized and furnace cooled low carbon steel.
b. Microstudy of Carburized, quenched and Low carbon steel.
c. Microstudy of Carburized, quenched, Sub-zero treatment and tempered low carbon steel.
d. Microstudy of Induction hardened steel.

Questions and Answers:

1. Draw heat treatment cycle for Annealing, Normalizing and Hardening process.
2. Draw heat treatment cycle for Carburized, quenched, Sub-zero treated and Tempered low carbon steel.
3. Draw the Hardness profile for Carburizing sample.
4. Draw the microstructure for a, b,c and d.

MUFFLE FURNACE



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ME-2204:Engineering Materials Sessional

Credit Hour: 1:50

Experiment No: 1

Metallography Specimen Preparation and Examination in order to reveal Microstructure.

Objectives

1. To learn and to gain experience in the preparation of metallographic specimens.
2. To familiarize with different types of Work materials for Specimen Preparation.

Abstract

Proper preparation of metallographic specimens to determine microstructure and content requires that a rigid step-by-step process be followed. In sequence, the steps include sectioning, mounting, course grinding, fine grinding, polishing, etching and microscopic examination. Specimens must be kept clean and preparation procedure carefully followed in order to reveal accurate microstructures. Each group of students will prepare and examine the given sample for metallographic examination.

The basic techniques can be learned through patient persistence in a matter of hours. This module takes the student through the metallographic sample preparation process step-by-step with demonstrations and explanations of sectioning, mounting, course & fine grinding, polishing, etching and microscopic examination.

Apparatus

1. Emery Paper
2. Acetone
3. Cotton wool
4. Etching Reagent
5. Wet polishing Machine
6. Alumina Powder

Nital, a Nitric Acid - Alcohol mixture, is the etchant commonly utilized with common irons and steels. Nital is dripped onto the specimen using an eye-dropper or cotton swab. Ten seconds to one minute is usually sufficient for proper etching depending on sample and nital concehtration.

Etchants

Materials	Composition	Application Procedure
Iron & Steel	1-5 Parts Nitric Acid 100 Parts Alcohol	Immerse/Swab
Copper & Brass	1 Part Ammonium Hydroxide 1 Part 3% Hydrogen Peroxide 1 Part Water	Swab
	5 g Ferric Chloride, 10 ml Hydrocloric Acid 100 ml Water	Immerse
Aluminum	5-10 g Ammonium Persulphate 1 ml Hydrofluoric Acid 99 ml Water	Immerse
	10 g Sodium Hydroxide, 100 ml Water	Immerse
Stainless Steels	10 g Oxalic Acid 100 ml Water	Use Electrolytically
	5 ml Sulfuric Acid 100 ml Water	Use Electrolytically

Lab Requirements

Each group of students will prepare the given specimen for microscopic observation. Prepare a metallographic specimen going through the coarse grinding, fine grinding, polishing and etching stages of specimen preparation. Clearly label your specimen and submit it with the lab write up; the quality of your specimen will be graded.