SAULT COLLEGE OF APPLIED ARTS & TECHNOLOGY

SAULT STE. MARIE, ONTARIO

COURSE OUTLINE

Course Title: METALLURGY

Code No.: MET 207-3

Program: MECHANICAL TECHNICIAN & MECHANICAL DRFTG. TECHNICIAN

Semester: FOUR

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New XX Revision:

APPROVED: ^O Chairperson & Date

Metallurgy MET 207-3

Course Nave **Course Number**

PHILOSOPHY/GOALS:

When the student has successfully completed this course of study, he/she should have a reasonable understanding of the material presented. The intention (therefore) is to provide students with sufficient background to assist others in the solution of work related (metallurgical) problems.

METHODS OF ASSESSMENT (GRADING METHOD):

3 Theory Tests	**70%**
1 Lab Report	**20%**
Attendance/Attitude	**10%**

(with **NO** incompletes)

TEXTBOQK(S):

"Metallurgy" by John and Weeks
(5th edition) American Technical Publishers.

OBJECTIVES;

The basic objective is to develop within the student an understanding of the concepts and procedures involved with this course of study as well as an ability to use them in the solution of problems. Theory tests and lab exercises are designed with this in mind.

The basic level of competency demanded is an over-all course average of 55% with no incompletes.

SPECIFIC OBJECTIVES

for

METALLURGY - MET 207-3

INTRODUCTION A*D ORIENTATION - 2 HRS. Handouts

The student should be given an opportunity to:

1) Identify and list the topics covered in this course.
2) Identify and list the general objectives of this course
3) Identify and list the various methods of evaluation used in this course outline.
4) Identify the grading system used in this course outline with respect to A, B_f C, R, I, X.
5) Identify the policy of this course with respect to
   a) attendance
   b) attitude
   c) due dates
   d) re-writes
   e) testing policies
   f) partial course credits
   g) employed students
6) Identify and list the various teaching methods used in this course outline.

PRODUCTION OP IRON AND STEEL - 4 HRS Text

The student should be given an opportunity to:

1) Name 4 iron ore minerals found in nature. p!4
2) Write the chemical formula that represents each of the iron ore minerals.
3) List the various impurities and gangue materials found in iron ores.
4) Name the furnace used to produce pig iron. pl9
5) Define the term **"reduction"** with respect to the blast furnace operation.
6) List 3 major steelmaking furnaces in use today. P29-31-34
7) Compare the **"quality"** of steels produced by the various steelmaking furnaces. Notes
8) List the general types of cast irons, cast steels, and rolled steels in use today. Handouts
9) Identify cast irons, cast steels, plain carbon steels, low alloy steels, stainless steels and tool steels according to their approximate carbon content, significant alloys and minor constituents Notes
10) State the main metallurgical reason for pouring molten steel into ingots. Text p41-42
11) List and briefly describe the various grades of ingot poured steels. Text p39
12) Explain (briefly) why the making of good ingots is one of the most important steps in the fabrication of steels. Text p39-40
13) List and briefly describe the major defects found in ingot poured steels.

3) HEAT TREATMENT - 8 HRS

The student should be given an opportunity to:

1) Develop a general understanding of the iron: iron-carbide system for steels with respect to: — Text pl47 pl60,r162
   a) Lower Critical Temperature
   b) Upper Critical Temperature
   c) Eutectoid Point and Composition
   d) Existing Equilibrium Structures
   e) The effects of Heating and Cooling with respect to Critical Temperatures.
2) Explain the changes in eutectoid, hypoeutectoid and hypereutectoid steels when they are heated from room temperature to above the upper critical temperature. — Handouts
3) Identify and select the proper temperature ranges for the following heat treating operations: — Text pl66
   anneal
   normalize
   harden
   temper
4) List the three requirements necessary to successfully harden steels. — Text P171-173
5) Explain the formation of martensite as a non-equilibrium structure.
6) State the theory that explains why martensite has such a high hardness. — Handout
7) Compare the hardness for the following ferrous crystalline structures:
   ferrite
   pearlite
   martensite
   cementite

4) SURFACE TREATMENTS - 2 HRS

The student should be given an opportunity to: - Text p205-206

1) State the purpose for which carburizing operations are carried out.
2) State the 3 main carburizing processes.
3) State the initial carbon content of steels used in carburizing operations.
4) Describe the effects of carburizing process on:
   a) The **"final"** carbon content of the steels.
   b) The **"final"** microstructure and hardness of the steels.
5) State which gas is used in the nitriding process.
6) State the relationship between the temperatures used in the nitriding process as compared to the carburizing process.
7) Identify the type of steel used in the nitriding — Text p214

process.

8) State which elements (in addition to carbon, manganese and silicon) are contained in steels used for the nitriding process. p215

9) Briefly explain how **"free"** nitrogen is produced. p216

10) Briefly explain how these nitrides harden the steel.

11) Describe the effets of the nitriding process on:
    a) The depth of case.
    b) The hardness of the core.

12) State the purpose for which flame hardening and induction hardening operations are carried out. Text

13) State the initial carbon content of steels used in the flame and induction hardening processes. p220-223

14) Describe the effects of the flame and induction hardening processes on:
    a) The **"final"** carbon content of the steels.
    b) The **"final"** microstructure and hardness of the steels.

5) **SHAPING AND FORMING OP METALS** - 5 **HRS** Text

The student should be given the opportunity to:

1) State the reason for placing ingots into soaking pits prior to rolling. p45

2) State the two purposes served by hot rolling and hot forging operations. p46

3) Draw the roll configurations for:
    a) Two-high reversing mill p50
    b) Universal Mill
    c) Four-high Mill

4) State how the rolls used to produce structural shapes differ from those used to produce flat sheet. p51

5) Define the terms; p53
    a) Hot working
    b) Forging

6) List 4 changes of internal structure in metals resulting from hot working. p56

7) Define the term **"recrystallization".** p56

8) State the most practical way to bring about recrystallization and grain refinement. p56

9) Describe the effects of plastic deformation on the dendritic structure and segregated impurities of ingot steels. p56-57 -58-59

10) State the purpose and effects of cold rolling operations.

11) State and describe the two broad classes of cold working operations. p71

12) Describe the deformation of aggregates in steel and other aggregates as a result of:
    a) Hot Working p72
    b) Cold Working

6) PROPERTIES OP METALS - 3 **HRS**

The student should be given an opportunity to:

1) Define the following terms:	Text
a) Yield Strength	p96
b) Ultimate Tensile Strength	97
c) Fatigue Strength	98
d) Elasticity	
e) Ductility	
f) Toughness	
g) Hardness	
2) Identify$_f$ list and compare selected mechanical properties of identified ferrous and non-ferrous metals.	plOl
3) Identify and list the carbon content and commercial use of selected carbon steels.	p90
4) Explain the relationship between carbon content and the properties of hot worked steel.	p91
5) Explain the susceptibility to corrosion of metals with respect to their relative position on the electrochemical series.	p98 99

NOTE: .Course objectives are subject to change due to such variables as:

i) field trips

ii) holidays

LAB EXPERIMENTS/OBJECTIVES

for

METALLURGY - MET 207-3

ROCKWELL HARDNESS - **2 HRS** Handouts

The student should be given an opportunity to:
1) Prepare and test steels for their initial hardness.
2) Explain the initial hardness of a steel in relation to its carbon content, and the P.F.C.S. chart.
3) Estimate the initial microstructure.

6 SAMPLES/GROUP REQUIRED

NORMALIZING - 3 **HRS** Handouts

The student should be given an opportunity to:
1) Determine the proper soaking time and temperature for his/her steel.
2) Heat treat steels for the purpose of changing their microstructure and hardness.
3) Prepare and test steels for their normalized hardness•
4) Recognize and explain a change in hardness due to normalizing.
5) Prepare and examine samples for microstructure.
6) Explain the changed hardness of a steel in relation to its carbon content, new micro-structure and the P.F.C.S. chart.
7) Name the new microstructure.
8) Describe the new microstructure.

6 SAMPLES/GROUP FROM EXPERIMENT # 1

3) QOEHCH HARDENING - 3 HftS Handouts

The student should be given an opportunity **to:**

1) Determine the proper soaking time and **temperature for** his/her steel.
2) Heat treat steels for the purpose of changing their microstruture and increasing the hardness.
3) Prepare and test samples for their quenched hardness.
4) Recognize and explain an increase in hardness due to water and oil quenching.
5) Prepare and examine samples for microstructure.
6) Explain the increased hardness of a steel in relation to its carbon content, new microstructure and the P.F.C.S. chart.
7) Name and describe the new microstructure.

3 SAMPLES/GROUP FROM EXPERIMENT # 2

4) TEMPERING - 3 **HRS** Handouts

The student should be given an opportunity to:

1) Determine the proper tempering time and temperature for his/her steel.
2) Heat treat steels for the purpose of reducing .their quenched hardness.
3) Prepare and test samples for reduced hardness.
4) Prepare and examine samples for microstruture.
5) Explain the steels reduced hardness in relation to its carbon content, microstructure and P.F.C.S. chart.
6) Name and describe the "new" microstructure.

3 SAMPLES/GROOP FROM EXPERIMENT # 3

5) HEAT TREAT REVIEW - **2 HRS** Handouts

The student should be given an opportunity to:

1) Review, compare and discuss the lab data.
2) Discuss changes in hardness and microstructure with respect to:
   - P.F.C.S. chart
   - Iron-carbide system
   - continuous cooling transformation phase diagrams.
3) Define the terms:
   - normalize
   - quench harden
   - temper
4) Discuss lab reports and format.

NOTE Lab experiments and objectives are subject to **change due to such** variables as:

i) field trips
ii) holidays
iii) equipment failure.

TOPIC NO.	PERIODS	TOPIC DESCRIPTION	REFERENCE
	2-T	**INTRODUCTION AND ORIENTATION** - course topics - general objectives - methods of evaluation - grading system - teaching methods - policy regarding a) attendance b) attitude c) due dates d) re-writes e) testing f) partial course credits g) employed students	handout
	4-T	**PRODUCTION OF IRON AND** STEEL - iron ore minerals, chemical formula and gangue materials - iron production via blast furnace reduction - types of steelmaking furnaces - general types of commercial ferrous metals and their chemical analysis - grades of ingot poured steels	Text ch. 2 & 3 handouts notes
	2-T	**THEORY** TEST # **1** FOR TOPICS 1 & 2	
	8-T 13-L	HEAT TREATMENT - general understanding of the iron; iron-carbide system for steels - changes insteels as they are heated - requirements to harden steels - formation and hardness of martensite - comparative hardness of ferrous crystalline structures	Text ch. 8 & 9 handouts

TOPIC NO.	PERIODS	TOPIC DESCRIPTION	REFERENCE
4	2-T	**SURFACE TREATMENTS** - purpose and methods of carburizing - effects of carburizing on steels - purpose of flame and induction hardening - effects of flame and induction hardening on steels - the nitriding process - effects of nitriding process	Text ch. 10
	2-T	**THEORY TEST #2 FOR TOPICS 3 & 4**	
	5-T	**SHAPING AND FORMING OF METALS** - purpose of hot rolling and hot forging - roll configurations for two-high reversing, universal and four-high mills - hot working, forging and recrystallization - changes in internal structure resulting from hot working - purpose and effects of cold rolling - classes of cold working operations - deformation of aggregats	Text ch.
	3-T	**PROPERTIES OF METAL** - definitions of identified mechanical properties and strengths - mechanical properties of metals - carbon content and commercial use of selected steels - relationship between carbon content and properties of hot-worked metals - susceptibility to corrosion	Text ch.

TOPIC NO.	PERIODS	TOPIC DESCRIPTION	REFERENCE
	2-T	THEORY TEST « 3 FOR TOPICS 5 6 6	

NOTE: Objectives are subject to change due to such variables as:

i) field trips
ii) holidays
iii) equipment failure