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SAULT COLLEGE OF APPLIED ARTS & TECHNOLOGY

SAULT STE. MARIE, ONTARIO

COURSE OUTLINE

COURSE TITLE: METALLURGY

CODE NO. MET 207-3 SEMESTER: FOUR

PROGRAM: MECHANICAL TECHNICIAN & MECHANICAL DRFTG. TECHNICIAN

AUTHOR: DENNIS SOCCHIA

DATE: 1990-12-12 PREVIOUS OUTLINE DATED:1988-06~14

APPROVED: L'Augutta
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TOTAL CREDIT HOURS: 45

PREREQUISITE(S):

Grade 12 reading, writing and comprehension skills or the equivalent.

I. PHILOSOPHY/GOALS: To provide students with a reasonable understanding of the concepts and procedures related to the fields of extractive and physical metallurgy, heat treatment, metals processing and mechanical testing. Ultimately, students should have sufficient background to assist others in the solution of work related (metallurgical) problems.

II. STUDENT PERFORMANCE OBJECTIVES;

Upon successful completion of this course, the student will:

1. Understand the process of extractive metallurgy specific to iron and steelmaking.
2. understand the concepts and procedures related to the heat treatment of carbon steels.
3. Understand procedures related to the shaping and processing of metals.
4. Understand and apply the procedures required for basic mechanical testing of metals.

III. TOPICS TO BE COVERED:

1. Course Introduction and Orientation
2. The production of Iron and Steel
3. The Heat Treatment of Carbon Steel.
4. The Surface Treatment of Metals
5. The Shaping and Firming of Metals
6. The Properties of Metals

NOTE: Course 'Objectives' and Topics* are subject to change due to the following variables:

i) field trips
ii) holidays
iii) equipment failure
iv) illness

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SPECIFIC OBJECTIVES FOR METALLURGY - MET 207-3

1) INTRODUCTION AND 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+, A, B, C, R, 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) course credits
   g) employed students
6) Identify and list the various teaching methods used in this course outline.

2) PRODUCTION OF IRON AND STEEL - 4 HRS Text

The student should be given an opportunity to:

1)	Name 4 iron ore minerals found in nature.	pl4
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.	
8)	List the general types of cast irons, cast steels, and rolled steels in use today.	Notes
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	Handouts
10)	List and briefly describe the various grades of ingot poured steels.	Text p4l-42
11)	Explain (briefly) why the making of good ingots is one of the most important steps in the fabrication of steels.	Text p39
12)	List and briefly describe the major defects found in ingot poured steels.	Text p39-40

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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
   a) Lower Critical Temperature — pl60,162
   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 — harden
   normalize — temper
4) List the three requirements necessary to successfully harden steels. — Text pl71-173
5) Explain the formation of martensite as a non-equilibrium structure.
6) State the theory that explains why martensite has such a high hardness.
7) Compare the hardness for the following ferrous crystalline structures: — Handout
   ferrite — martensite
   pearlite — cementite

4) SURFACE TREATMENTS - 2 HRS

The student should be given an opportunity to:
1) State the purpose for which carburizing operations are carried out. — Text p205~206
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 process. — Text p214

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 effects 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 OF 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 b) Universal Mill c) Four-high Mill	p50
4)	State how the rolls used to produce structural shapes differ from those used to produce flat sheet.	p51
5)	Define the terms; a) Hot working b) Forging	p53
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) Cold Working b) Hot Working	p72

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6) **PROPERTIES OF 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, list and compare selected mechanical properties of identified ferrous and non-ferrous metals.	pIOI
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

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LAB EXPERIMENTS/OBJECTIVES FOR METALLURGY - MET 207-3

1) 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

2) 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 microstructure and the P.F.C.S. chart.
7) Name the new microstructure.
8) Describe the new microstructure.

6 SAMPLES/GROUP FROM EXPERIMENT # 1

3) QUENCH HARDENING - 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 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

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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 microstructure.
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/GROUP 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.

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EVALUATION METHODS: (INCLUDES ASSIGNMENTS, ATTENDANCE REQUIREMENTS, ETC.):

General Assessment			Final Mark *	
A+	=	90 - 100%	Test #1	25%
A	=	80 - 89%	Test #2	25%
B	=	70 - 79%	Test #3	25%
C	=	60 - 69%	Report #1	25%
R •	=	0 - 5 9 %	Attendance ** (See Attached)	

VI. REQUIRED STUDENT RESOURCES:

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

Safety Glasses - (Impact Resistant, CSA Approved)

VII. ADDITIONAL RESOURCE MATERIALS AVAILABLE IN THE COLLEGE LIBRARY BOOK SECTION:

TO BE ANNOUNCED

VIII. SPECIAL NOTES:

* Student evaluations concerning the 'Final Mark' are further affected by the conditions set forth in the printed handout 'Guidelines for Metallurgy*. BE SURE TO OBTAIN A COPY FROM YOUR INSTRUCTOR.

Special guidelines for attendance are included in the above noted paper.