SAULT COLLEGE OF APPLIED ARTS & TECHNOLOGY

SAULT STE. MARIE, ONTARIO

COURSE *OUTLINE*

COURSE TITLE:	***Metallurgy***
***CODE* NO.;**	*b\z.r z\ 2,*
PROGRAM:	*Mechonicol (Engineering) Technology*
SEMESTER:	*Four*
DATE:	*1986 05* J4
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NEW: X ***REVISION:^***

APPROVED: _____

Chairperson ***Date***

METALLURGY

MECHANICAL ENGINEERING TECHNOLOGY

CALENDAR DESCRIPTION

A combination of lab and theory designed to provide Mechanical Engineering Technologists with the basics of Metallurgy.

More specifically, it deals with the production of iron and steel; heat treating and surface treatments, phusical metallurgy as well as the theory of alloys.

METALLURGY

MECHANICAL (ENGINEERING) TECHNOLOGY

Metallurgy

Course Name ***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.

METHOD OF ASSESSMENT (GRADING METHOD):

3 Theory Tests	*10%*
1 Lab Report	*20%*
*Attendance/Attitude (with **NO** incompletes)*	*10%*

TEXTBOOK(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 60% with no incompletes.

TOPIC NO.	PERIODS	TOPIC DESCRIPTION	REFERENCE
		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*	***Handout***
		PRODUCTION OF IRON AND STEEL - *iron ore minerals, chemical formula and gangue materials* - *iron production via blast furnace reduction* - *types of steeimoking furnaces* - *general types of commercial ferrous metcls and their chemical analysis* - *grades of ingot poured steels*	***Text Ch 2 & 3 P13, P21*** ***Handout***
		THEORY TEST # 7 - TOPICS h 2	
8 20		***HEAT TREATMENT*** - *general understanding of the iron; iron-carbide system for steels* - *changes in steels as they ore heated* - *temperature ranges for heat treatment* - *requirements to harden steels* - *formation and hardness of martensite* - *comparative hardness of ferrous crystalline structures*	***Text*** *Ch* ***8,*** *9* **P746,** ***165*** ***Handout***
2 - T		***SURFACE TREATMENTS*** - *purpose and methods of carburiz'mg* - *effects of carburiz'mg on steels* - *purpose of flame and induction hardening* - *effects of flame and induction hardening on steels*	***Text Ch 10*** ***P205***
		THEORY TEST # 2 - TOPICS 3 / 4	

TOPIC NO.	PERIODS	TOPIC DESCRIPTION	REFERENCE
	4 - 7 "	***PHYSICAL METALLURGY***	*jext*
		- crystalline structure of metals and common space lattice types	*Ch 5*
		- the manner of crystallization	*""**
		- the concepts of workhardening as o result of cold working and the tensile test	
		- the concepts of re-crystallization and grain growth in terms of strength hardness, grain shape, stress relief and annealing	
		THEORY OF ALLOYS	
		- the construction of alloy diagrams	***Text***
		*- the formation of type I, type **II***	**^n °**
		and type ill alloys.	pj3j
		THEORY TEST # 3 - TOPICS 5, 6	
		LAS *EXPERIMENTS*	
		ROCKWELL HARDNESS AND MICROSTRUCTURES	
		- prepare and test samples for hardness	
		- recognize hardness of samples with respect to carbon content and initial condition of sample	***Handouts***
		- prepare and observe samples for initial microstructure	
		- recognize microstructure with respect to initial condition of sample	
		*- develop an understanding of the term **NORMALIZE***	
		(U SAMPLES REQ'D/GROUP)	
		ANNEALING AND HARDENING	
		- heat treat scmpies for the purpose of changing their hardness and microstructure	***Handouts***
		- prepare and test samples for hardness	

TOPIC NO.	PERIODS	TOPIC DESCRIPTION	REFERENCE
		recognize changes in hardness with respect to annealing and hardening *prepare and test samples for microstructure* *recognize changes in microstructure with respect to annealing and hardening* *develop an understanding of the terms* ***ANNEAL/HARDEN***	***Handouts***
		(6 SAMPLES REQ'D/GROUP FROM # 1 ;	
		TEMPERING - *heat treat samples for the purpose of changing their* ***"hardened"*** *microstructures* - *prepare and test samples for hardness* - *recognize changes in hardness with respect to tempering* - *develop an understanding of the term* ***"TEMPER"*** *(3* ***SAMPLES/GROUP*** *REQ'D* ***FROM # 2)***	***Handouts***
		QUENCH MEDIA - *harden samples by quenching in various cooling media for the purpose of inducing a variety of hardness and microstructure changes* - *prepare and test samples for hardness and microstructure* - *recognize changes in hardness and microstructure* - *develop an understanding of the effect of quenching media* *(6* ***SAMPLES/GROUP REQ'D FROM # Z)***	***Handouts***
		HEAT TREAT REVIEW - *review and discuss fab data* - *discuss changes with respect to:* *a) iron-carbide system* *b) LT. and C.C.T. diagrams* - *discuss the terms* ***NORMALIZE, ANNEAL, HARDEN, TEMPER.***	***Text***

TOPIC NO.	*PERIODS*	*TOPIC DESCRIPTION*	*REFERENCE*

- *discuss the effects of QUENCH MEDIA*
- *complete Jab reports*

NOTE: Course objectives and lab topics ore *subject to change with advance notice.*

SPECIFIC OBJECTIVES

for

METALLURGY - MET - 3

INTRODUCTION AND ORIENTATION - 2 HRS.

The student should be given on 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, 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
6) Identify and list the various teaching methods used in this course outline.

PRODUCTION OF IRON AND STEEL - 4 HRS.

The student should be given an opportunity to:

1) Name 4 iron ore minerals found in nature.
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.
5) Define the term "reduction" with respect to the blast furnace operation.
6) List 3 major steelmaking furnaces in use today.
*7) Compare the **"quality"** of steels produced by the various steelmaking furnaces.*
8) List the general types of cost irons, cast steels and rolled steels in use today.
9) Give the approximate carbon content, significant alloys and minor constituents found in cast irons, cast steels and roiled steel sections.
10) State the main metallurgical reason for pouring molten steel into ingots.
11) List and describe (briefly) the various grades of ingot poured steels.
12) List the major defects found in ingot poured steels.

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:
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.
3) Identify and select the proper temperature ranges for the following heat treating operations:
   anneal
   normalize
   temper
   harden
4) List the three requirements necessary to successfully harden steels.
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:
   ferrite
   pear lite
   martensite
   cementite

SURFACE TREATMENTS - ***2 HRS.***

The student should be given an opportunity to:

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 the carburizing process on:
   a) The ***"final"*** carbon content of the steels.
   b) The ***"final"*** microstructure and hardness of the steels.
5) State the purpose for which flame hardening and induction hardening operations ore carried out.
6) State the initial carbon content of steels used in the flame and Induction hardening processes.
1) 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.

PHYSICAL METALLURGY - **4** HRS.

The student should be given on opportunity to:

1) Explain and define the solid or ***"crystalline structure"*** of metals in terms of:
   c) the arrangement of atoms
   b) the space lattice of atoms
2) List, drew and label the following three common space lattice types:
   a) body-centered cubic
   b) face-centered cubic
   c) close-packed hexagonal

3) Explain the manner of crystallization of metals by means of the following progressive stages:
   a) liquid
   b) nucleation
   c) crystal formation
   d) grain growth
   e) segregation of impurities
4) Explain in simple terms the concept of **"work hardening"** as a result of cold working and the tensile test in terms of:
   a) the amorphous cement theory
   b) the slip interference theory with reference to cleavage and slip planes
5) Explain the theory of recrystaliization and grain growth in terms of:
   a) the effects of work-hardening on strength, hardness and grain shape.
   b) the effects of stress relief and annealing upon the strength, hardness and grain size of the metal.

THE THEORY OF ALLOYS - 4 HRS.

The student should be given an opportunity to:

1) Explain how it is possible to construct on alloy diagram for metals from the study of cooling curves produced by thGt metal.
2) Explain the process of formation for a solid solution alloy using a 50 - 50 copper-nickel alloy.

2b) State how the heterogeneous (ie non-uniform) cored structure of a solid solution alloy:
   o) comes into being
   b) can be corrected

3) Explain the process of formation for a eutectic alloy using a 25 - 15 cadmium - bismuth alloy.
4) Explain the process of formation of a type III alloy using an 80 - 20 copper - silver alloy.

NOTE: SUBJECT** TO **CHANGE