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SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY

SAULT STE. MARIE, ON

COURSE OUTLINE

COURSE TITLE: MANUFACTURING PROCESSES

CODE NO.: MCH 244 **SEMESTER:** THREE

PROGRAM: MECHANICAL TECHNICIAN

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DEAN DATE

MANUFACTURING PROCESSES — COURSE NAME

MCH 244 — CODE NO.

TOTAL CREDIT HOURS 60

PREREQUISITE(S): NONE

I. PHILOSOPHY/GOALS:

Upon completion of this course, the student should have a basic understanding of the major processes involved in the manufacture of basic and secondary products. One important benefit is that the student would have some knowledge of the manufacturing facility he/she might enter upon graduation.

The student will be familiar with foundry methods, hot working of metals, cold working of metals, powder metallurgy, joining processes, plastics and composites, and costing of manufactured goods.

II. STUDENT PERFORMANCE OBJECTIVES:

Upon successful completion of this course the student will:

1) Use the terminology of manufacturing.

2) Read and interpret textbook technical explanations.

3) Prepare and present oral and written explanations of various manufacturing processes.

4) Determine a basic knowledge of the processes involved in powder metallurgy and plastics manufacture.

5) Prepare simple cost estimates for manufactured parts.

III. TOPICS TO BE COVERED:

A) Foundry Processes

B) Hot Metal Working

C) Cold Working

D) Powder Metallurgy

E) Plastics and Composites

IV. LEARNING ACTIVITIES	REQUIRED RESOURCES
1. FOUNDRY PROCESSES a) Types b) Sand Prep c) Pattern Making d) Mould Making e) Core Making f) Other Methods & Costs	TEXT: Modern Materials & Manufacturing Processes Chapter 7 Film
2. HOT METAL WORKING a) Hot Rolling b) Rolling Mills c) Strand Casting d) Forging e) Other Methods & Costs	Chapter 8 Film
3. COLD WORKING a) Cold Hardening b) Preparation c) Cold Rolling d) Blanking and Pressing e) Drawing Forming Extruding f) Bending Straightening g) Roll Forming h) Shearing	Chapter 9 Film
4. POWDER METALLURGY a) General Process b) Metal Powders c) Compacts d) Sintering e) Other Operations	Chapter 10
5. PLASTICS AND COMPOSITES a) Moulding Techniques b) Reinforced Plastic Materials c) Composites Manufacturing d) Tool & die Making	Chapter 15 Film

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

There will be 4 topical tests throughout the semester with the tests approximately equal in value. The overall mark would then be calculated as the simple average.

A+	=	91 - 100%
A	=	80 - 90%
B	=	69 - 79%
C	=	55 - 68%
X or R	= <	55%

If, at the end of the semester, the average of all the tests is less than 55% then you would be permitted to rewrite tests to raise your topic marks. You would be allowed one rewrite per topic. If your overall average fails to rise above 55% then you would be assigned an "R" grade and would be obliged to repeat the course.

VI. **REQUIRED STUDENT RESOURCES**

TEXT -- Modern Materials & Manufacturing Processes

SPECIFIC OBJECTIVES

1) FOUNDRY PROCESSES

At the conclusion of this topic the student will be able to:

1. List the major reasons that people choose CASTING over other methods.
2. Outline the general series of steps involved in casting a simple part, describing sand casting methods.

SAND PREPARATION

3. Explain the difference between "Green Sand" and "Dry Sand".
4. List and describe the properties of a good moulding sand.

PATTERN MAKING

5. Explain what a pattern is and how a pattern for a hollow sleeve could be made. Use sketches.
6. Explain: a) what a shrink rule is and does
   b) what Draft is and why it is necessary on a pattern

MOULD MAKING

7. Make a sketch showing a cross-sectional view of a flask showing the cavity and cores required to produce the shape shown in figure 16 on page 150.

CORE MAKING

8. Sketch an ordinary core-box.
9. Summarize the advantages and disadvantages of sand casting.

EVAPORATIVE CASTING

10. Describe the process called "Evaporative Casting".

STEEL CASTING

11. Explain why casting with steel is more difficult than casting with iron.

SHELL CASTING

12. Explain how a shell mould is made and why it is used.

PERMANENT MOULDING

13. Explain the difference between permanent moulding and sand moulding.

CENTIFUGAL CASTING

14. Describe, using sketches, how a short pipe section could be made by centrifuge.

INVESTMENT MOULDING

15. Explain how you could make a trophy figurine using the lost wax method.
16. Explain how precision castings are made by the "investment shell process".
17. Explain the "Shaw" process.

DIE CASTING

18. State the major difference between "die casting" and "sand casting".
19. Explain why "die casting" is better for strength than "sand casting".
20. List and compare the three major methods for injecting hot metal.

2) HOT METAL WORKING

At the conclusion of this topic the student would be able to:

1. Describe generally the processes that transform molten metals into useful shapes.
2. Explain what happens to grain and grain structures as metals are cast and hot worked.
3. Describe processes for hot-forming metals into billets, strip, plate, pipe and tubing.
4. Explain that after the steelmaking furnace, hot metal is poured into ingots in preparation for reheating in the soaking pits and subsequent rolling in the rolling mills.

SOAKING PITS

5. Explain the importance of thorough reheating of the ingot in the soaking pits.

ROLLING MILLS

6. Make a sketch of a basic rolling line showing the components involved from the soaking pits to the cooling beds.

7. Devise the rolling procedure used in the film to roll a 26 x 26 ingot to 9 x 9 bloom.

8. Explain where grey mill scale come from, why it must be removed from the red hot steel surface and what future uses mill scale could have.

STRAND CASTING

9. List the processes eliminated by strand casting and explain how it is done.

10. Make a sketch showing the variation in grain structures that occur in a slowly cooling ingot.

11. Explain what recrystalization is and how grain growth can be encouraged or discouraged.

ANISOTROPHY

12. Explain what anisotrophy is and how it affects directional strength in rolled steel plate.

FORGING

13. Explain what forging is.
14. State the major advantages of forging.
15. List five different forging methods and differentiate between them.
16. Explain how a drop hammer forge works.
17. State why a hydraulic press is special.

FORGING DIES

18. List the special requirements of forging dies.
19. List the advantages of forging of metals.

HOT UPSET FORGING

20. Explain what the term "hot upset forging" means.
21. List several products of the process.
22. State what metal and alloys are used for quality hand-tools, why they are upset.

SWAGING

23. Explain what "swaging" means and provide an example.
24. State the range in cycles/min of a rotary swaging machine as it delivers "swaging blows".

HOT EXTRUSION

25. Use a simple example how metals could be hot or cold extruded.
26. Explain what a "spider mandrel" is.
27. Make a sketch of a forward extrusion machine producing a metal toothpaste tube.

HOT DRAWING

28. List 3 products manufactured by hot-drawing.
29. State the major advantage of hot-drawing over cold-drawing.

HOT SPINNING

30. Make a sketch illustrating how spin forming is done.
31. List one important product of hot spinning.

SEAMLESS TUBE

32. Explain with sketches how a solid tube-round can be formed into a seamless tube.

PIPE WELDING

33. Explain why welded pipe is not acceptable for hydraulic systems.
34. Explain how welded pipe is made.

3) COLD WORKING PROCESSES

At the conclusion of this topic the student would be able to:

1. Explain in general terms the processes that immediately proceed cold working.
2. Write a paragraph explaining why metals are cold-worked. Include information about advantages and disadvantages, and the differences between 1/4 hard and full hard steel.

ELASTIC RECOVERY

3. Explain why "springback" is important to account for.

CHARACTERISTICS

4. Define Ductility and Malleability.

PREPARATION FOR COLD-ROLLING

5. Explain how hot-rolled strip is cleaned and descaled. Name the process.

COLD-ROLLING

6. Describe the shape of a cold rolled crystal.
7. Describe the process that immediately follows cold rolling and why it is essential that it be carried out before further cold working is done.
8. Explain what a temper mill does to finish the steel surface and thickness.
9. Today a lot of strip product owes its existence to a SENDIZMER mill. What is so special about this mill? Make a sketch of the roll cluster.
10. Explain why steel products are coated and list some of the costs that are applied, and the methods used to apply them.

BLANKING AND PRESSING

11. Make a list of the major blanking and pressing operations and explain what each means.
12. Make a sketch of a punch and die combination, label the parts and features and show where tapers and clearances must be.
13. Explain what a steel rule die is and what it does.
14. In figure 18 a strip of electrical outlet boxes in process is shown. Explain how a progresses die machine works.

CUP DRAWING

15. Make sketches to explain how a simple metal cup is formed by drawing.

WIRE DRAWING

16. Make a sketch of a draw bench for seamless tubing.
17. Explain how copper wire is drawn to size using progressive dies. (As seen on the ACME School of Stuff Video)

COLD HEADING

18. Make a list of some small parts that can be formed by the process called COLD HEADING.
19. Make a sketch of the die set that could be used to form the head of a stove bolt.
20. List and sketch the five basic operations that can be performed in cold-forming machines.
21. Sketch the progression of upsets and extrusions used to make spark plug center posts.

COLD-FORMING THREADS

22. List the factors in the decision to machine or cold-roll threads.
23. Sketch two thread profiles showing the fibre lines under rolled thread vs cut threads.
24. Explain how internal threads can be roll-formed.

EXTRUSION

25. List several soft metals that can be cold extruded.
26. Make sketches that differentiate between direct (forward), indirect (backward) and impact extrusion.

BENDING, STRAIGHTENING AND ROLL FORMING

27. Sketch the die set shapes needed to make the PITTSBURGH LOCK SEAM.
28. Make a sketch of several roll sets needed to form a metal eavestrough section.
29. Explain how stretch-wrap forming works.
30. Explain how explosion forming can be used to clad one metal to another.

METAL SPINNING

31. Name some products of the spinning process and sketch how it works.
32. Explain how a hollow tube can be flow-formed.

PIPE FORMING

33. Make a sketch showing how steel pipe is rolled to shape and edge-welded.
34. Illustrate to explain how larger diameter pipe such as those used for gas and oil pipelines are made.

RUBBER PAD PRESSES

35. Make a sketch illustrating the use of the Guerin process to form a cup.

NOTE TO THE STUDENT: The instructor often uses the REVIEW QUESTIONS section as a source of test items.

4) POWDER METALLURGY

At the conclusion of this topic, the student would be able to:

1. List and explain the three steps involved in the manufacture of parts by P.M. means.
2. Make a list of the secondary processes that are applied to P.M. products and explain why they are carried out.

METAL POWDERS

3. List and describe the methods of powder production.
4. List the various metals that are consumed in the P.M. industry.

COMPACTING METAL POWDERS

5. State why metal powders are compacted and make a sketch of the arrangement illustrated in figure 6 of the text.
6. Make a list of the kinds of presses used in order of industry preference.

ADVANCED PROCESSES

7. State the advantage of hot pressing of powders.
8. Describe cold isostatic pressing.
9. Describe hot isostatic pressing.
10. List some advantages and disadvantages of the isostatic processes.

POWDER FORGING

11. Explain how powder forging works and why it is done.

P.M. INJECTION MOULDING

12. Explain how this process works and why it is done.

P.M. STRIP

13. Explain how strip can be made from a slurry of powder. Make a sketch of the process.

POWDER EXTRUSION

14. Explain how metal powders can be extruded.

SINTERING

15. Explain the difference between solid and liquid phase sintering.
16. List the three major changes that take place in solid phase sintering.
17. Describe "infiltration" as it applies to liquid phase sintering.
18. Describe typical P.M. processes for the following P.M. products:
    - Refractory metals
    - Cemented Carbides
    - Oil Impregnated Bearings
    - Porous Metal Filters
    - Ordinary Ferrous Machine Parts
    - High Strength Machine Parts

SECONDARY OPERATIONS

19. Explain why "sizing" is necessary and how it is done.
20. Explain how a P.M. bronze bearing can be made self-lubricating.
21. State the hazard involved in attempting to electroplate P.M. parts.
22. State the special requirements for heat treating of P.M. parts.

PRODUCTS AND THEIR USES

23. List the ten features of P.M. parts that make them attractive over other methods.
24. Explain the process of making an automotive bearing insert by P.M.

DESIGN FOR P.M.

25. Make comments concerning the following design features of P.M. parts:
    a) feather edges
    b) fillet radii
    c) internal holes
    d) external corners
    e) narrow deep slots
    f) splines and keyseats
26. List the part features that must be machined into a part later.
27. List some features of parts that would be impossible to have without P.M. technology.

5) PLASTICS AND COMPOSITES

At the conclusion of this topic the student will be able to:

1. Identify common methods of processing plastics and composites.
2. Describe in general terms how processes work.

BLOW MOULDING

3. Making reference to the BLOW MOULDING film sequence, explain how plastic wine barrels are made.
4. Make a sketch showing how a variation of the methods above is used to form plastic bath tubs.

INJECTION MOULDING

5. Make a simple sketch explaining how INJECTION MOULDING works.
6. List some examples of injection moulded products.

EXTRUSION MOULDING

7. Recalling the extusion information on the film, explain how plastic siding is manufactured.

REINFORCED PLASTIC MATERIALS

8. List the materials that can be used to reinforce plastics.
9. List the major stages in the development of a fibre-glass product from idea to manufacture.

COMPOSITE MATERIALS

10. Define what a composite material is.
11. State some of the uses of composite materials.
12. State the reason that thermostats are the kind of resins that will likely be used in COMPOSITE technology.

COMPOSITE MANUFACTURING

13. Explain PULLTRUSION, and state some products.
14. Describe the process called Filament winding and state a product.