



Frank Phillips College  
1301 West Roosevelt POB 5118  
Borger, TX 79008-5118  
(voice) 806.274.5311  
(fax) 806.274.9834



## 1. General Course Information

- 1.1. **Course Number:** INMT 1349  
1.2. **Course Title:** Introduction to Manufacturing Technology  
1.3. **SCH [Semester Credit Hours]:** 3 **CEU [Continuing Education Units]** 4.8

**NB: CLASS CAN NOT BE TAKEN FOR BOTH ACADEMIC AND CEU CREDIT AT THE SAME TIME**

- 1.4. **Pre-requisites:** none  
1.5. **Co-requisites:** none  
1.6. **Course Description:**

- 1.6.1. What the THECB/WECM says:

Course description:

A basic study of various materials used in the metals industry and the chemical, physical, and mechanical properties of various metals. Emphasis on manufacturing processes including casting, forming, machining and molding.

- 1.6.2. WHAT THE INSTRUCTOR SAYS:

This is a 64 TOTAL contact hour course including tests and breaks. THE CHOICE THEREFORE IS BETWEEN SUPERFICIAL COVERAGE OF A LARGE NUMBER OF TOPICS OR IN-DEPTH [AND IN MY OPINION, MORE USEFUL] COVERAGE OF A SMALL NUMBER OF TOPICS.

This course is specifically intended to provide local area manufacturing and repair organizations with the ability to safely, quickly and economically locally produce prototypes and replacement parts for obsolete equipment with the auxiliary benefit of teaching individuals how to produce both utilitarian and decorative articles for their own use. To the extent practicable, this will be a “hands on” class stressing safety, and the “one-off” or very low volume production by casting using simple, low-tech processes and equipment.

Ferrous metals (steel and cast iron) properties will be discussed. The major differences between ferrous and nonferrous casting will be discussed, as will alternative forming methods such as sintering/powder metallurgy. The major reason ferrous casting is not performed is that FPC currently lacks ferrous casting capability. Metal stamping/pressing and forging will be [lightly] covered. *Machining will be mentioned only in passing as this is covered in depth in other classes such as lathe and mill operation.*

As in almost all vocational classes, the student desiring mastery of all topics covered should expect to spend considerable time participating in the “lab” sessions, applying and practicing the methods and techniques described during classroom instruction. The major lab emphasis will be on “hands on” casting of nonferrous metals to produce useful and decorative items.

Some of the major topics will be:

- 1.6.3. Composition and properties of common nonferrous alloys  
1.6.3.1. Zinc based  
1.6.3.2. Aluminum based  
1.6.3.3. Copper based [brass and bronze]  
1.6.3.4. Lead/tin based [solder, babbet]
- 1.6.4. Composition and properties of common ferrous alloys  
1.6.4.1. Regular cast iron  
1.6.4.2. Malleable cast iron  
1.6.4.3. Low carbon steel  
1.6.4.4. High carbon steel

- 1.6.4.5. Alloy steel
- 1.6.4.6. Alloys in which iron is not the major ingredient
- 1.6.4.7.
- 1.6.5. Patterns
  - 1.6.5.1. Commercial wood and metal
  - 1.6.5.2. Wax [primarily for small utility and decorative items]
  - 1.6.5.3. Plaster [primarily for “one-off” items]
  - 1.6.5.4. Broken/worn-out parts [primarily for replacement parts]
  - 1.6.5.5. “Lost foam”/EPS
- 1.6.6. Molds
  - 1.6.6.1. Green [damp] sand [not used but discussed]
  - 1.6.6.2. Oil sand [our usual method] commercial Petrobond and how to mix your own
  - 1.6.6.3. Plaster / Investment
  - 1.6.6.4. Elastomeric [not used but discussed]
- 1.6.7. Sand Molding Processes & Techniques
  - 1.6.7.1. Cope & Drag
  - 1.6.7.2. Open back
  - 1.6.7.3. Sprues, gates, runners, and risers
  - 1.6.7.4. “Ramming up”
- 1.6.8. Tools
  - 1.6.8.1. Furnaces [Home and small shop construction will be discussed]
  - 1.6.8.2. A Hot wire foam cutters for lost foam patterns will be constructed as a class project
  - 1.6.8.3. Sand Mullers [mixers]
  - 1.6.8.4. Riddles
  - 1.6.8.5. Slicks
  - 1.6.8.6. Rammers
  - 1.6.8.7. And much, much more...

2. **Semester/year:** Spring 2004

3. **Instructor:**

- 3.1. **Name:** Dr. F. George McDuffee<sup>1</sup>
- 3.2. **Office:** Library Building Room L10 or CAI-104A on the Borger Campus
- 3.3. **Extension:** (w) 806.274.5311 X791 (L10) or X806 (CAI104) (h) 806.274.2113
- 3.4. **Office Hours:** 9AM/4PM M-F however call as I am frequently out of the office or try CAI-104
- 3.5. **Email:** gmcduffee@fpc.cc.tx.us

4. **Objective of this class:** On successful completion of this course the participant will be able to demonstrate an ability to:

- 4.1. What the THECB/WECM says:  
At the successful completion of this course the student will be able to: Identify various metals such as ferrous and nonferrous metals; describe the different manufacturing processes; identify by code and color the different types of metals; perform the test necessary to determine the kind of metal being used; define the type of process the metal was made from; and determine whether it is a casting or forging.

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<sup>1</sup> AS Coffeyville Junior College 1960, BS [Applied Mathematics and Statistics] Southern Illinois University at Edwardsville, 1969, MS [Manufacturing Technology] Pittsburg State University 1993, EdS [Industrial Education] Pittsburg State University 1995, EdD [Occupational and Adult Education] Oklahoma State University 1999. With some overlap, 30 years manufacturing, 15 years consulting [technology transfer] and 10 years teaching.

4.2. What the instructor says:

At the successful completion of this course the student will be able to:

- 4.2.1. Describe the fundamental categories of engineering/manufacturing materials
- 4.2.2. Describe the fundamental manufacturing operations
- 4.2.3. Explain the relationship between suitable production techniques and anticipated production volumes
- 4.2.4. Use the Machinery's Handbook (or other recognized reference) to determine suitable types of steel and other alloys for given uses
- 4.2.5. Use the Machinery's Handbook (or other recognized reference) to determine the chemical composition of steel and other alloys from their SAE/AISI designations.
- 4.2.6. List and defend the major foundry safety rules
- 4.2.7. Name and describe the most common types of molding sand used in foundries
- 4.2.8. Hand ram small open back and cope-and-drag sand molds
- 4.2.9. Hand cut suitable sprues, gates, risers, vents and runners in small sand molds
- 4.2.10. Name the major equipment and common tools in a foundry
- 4.2.11. Hand pour small aluminum and zinc castings in sand, plaster and other molds
- 4.2.12. Use a hot wire foam cutter and white glue to produce simple multi-piece "lost-foam" patterns
- 4.2.13. Describe and explain the "lost wax"/investment casting procedure
- 4.2.14. Describe and explain the difference between white and gray cast iron
- 4.2.15.

5. **Textbook and Other Required Materials (text and all materials indicated below should be brought to every class session)**

- 5.1. **NO TEXT REQUIRED** however see suggested reading
- 5.2. Quadrille ruled lab type notebook such as Ampad #26-251 at the FPC bookstore -- If you bought one of these for my lathe/mill classes, continue to use until it is full. (8.5 X 11 spiral bound notebook is an acceptable alternative.)
- 5.3. File folder for class hand outs
- 5.4. #2 or softer lead pencil 0.5 mm or larger lead suggested
- 5.5. extra leads if mechanical or drafting style pencil selected for above
- 5.6. white vinyl eraser
- 5.7. blue erasable ball point pen
- 5.8. red erasable ball point pen
- 5.9. black erasable ball point pen
- 5.10. High-lighter
- 5.11. 25-50 paperclips
- 5.12. Book-bag or backpack to contain above materials
- 5.13. **Safety goggles or safety glasses with side-shields** must be worn in the foundry area whenever hot metal is present. **Full face shields, gloves, aprons, and safety "spats" will be worn by everyone actually engaging in pouring hot metal.**
- 5.14. **Suitable footwear**, safety [steel toe] caps lacing over ankle [high-tops] or engineer/cowboy boots preferred. ***Absolutely no thongs/flip-flops, no open-toed sandals, no open-back clogs or bare feet in the foundry area when hot metal is present.***

6. **Additional/Supplemental References [many of these are available at the FPC Library in the "Betty and 'Mac' McDuffee" collection]**

- 6.1. If you are going to buy a book – get this one. The US Navy foundry manual will be the basis for instruction for several reasons: (1) It is one of the least expensive texts available. (2) It was written for foundry operations on Navy repair ships where the space and facilities are limited and single or only a few parts are produced. (3) It is NOT written in academic or scientific/technical jargon, but rather in a style/language most anyone can understand. (4) It has lots of pictures. (5) Emergency/expedient alternatives are suggested when "exactly" the right materials/equipment is not available. (6) The instructor likes it.

This is a reprint of a 1944 Navy manual updated in 1958 and reprinted by Lindsay Books. You can see their description at <http://www.lindsaybks.com/bks/foundry/index.html> This book currently sells for \$19.95 + \$1.50 S/H for one book. If you order more than one book S/H is \$0.50 for each additional book.

- 6.2. Gingery, D Building a Gas-fired Crucible Furnace Bradley, IL: Lindsay Publications
- 6.3. Gingery, D. "Lil Bertha" Electric Furnace Bradley, IL: Lindsay Publications
- 6.4. Gingery, D. How to Design & Build Centrifugal Fans Bradley, IL: Lindsay Publications
- 6.5. Gingery, D. Making Crucibles Bradley, IL: Lindsay Publications
- 6.6. Goodman, H and Holmes, B. Building an Atmospheric Forge and Heat Treat Oven Bradley, IL: Lindsay Publications
- 6.7. Chastain, S. An Oil-fired Tilting Furnace Bradley, IL: Lindsay Publications
- 6.8. Green Sand Casting (reprint) Bradley, IL: Lindsay Publications
- 6.9. Woodwort, J.V. Hardening, Tempering, Annealing, and forging of Steel (reprint) Bradley, IL: Lindsay Publications
- 6.10. Marshall, S. Building Small Cupola Furnaces Bradley, IL: Lindsay Publications
- 6.11. Kirk, E. The Cupola Furnace (reprint) Bradley, IL: Lindsay Publications
- 6.12. Chastain, S. Iron Melting cupola Furnaces Bradley, IL: Lindsay Publications
- 6.13. Anderson, R. J. Melting and Casting Aluminum Bradley, IL: Lindsay Publications
- 6.14. Chastain, S. Metalcasting – a Sand Casting Manual for the Small Foundry -- Part 1 Bradley, IL: Lindsay Publications
- 6.15. McCaslin, H. J. Wood Pattern-Making (reprint) Bradley, IL: Lindsay Publications
- 6.16. Whitmoyer, R. Ornamental Metal Casting Bradley, IL: Lindsay Publications
- 6.17. Hall, R. J. Practical Wood Patternmaking (reprint) Bradley, IL: Lindsay Publications

## 7. Classroom Policy and Instructor Expectations

- 7.1. The students and instructor will show mutual respect at all times. *Please see the S.C.A.N.S. section below for additional discussion on this point.*
- 7.2. Behavior inconsistent with a safe and student-friendly learning environment for all students is not acceptable. *Please see the S.C.A.N.S. section below for additional discussion on this point.*
- 7.3. Habits of neatness and safety are common workplace requirements. They are therefore required in this class. *Please see the S.C.A.N.S. section below for additional discussion on this point.*
- 7.4. Honesty is expected of all students. Cheating and plagiarism are violations of honesty. Cheating occurs whenever one uses deceitful means, for example crib notes or copying assignments. Plagiarism is presenting the language and ideas of another as ones own work such as coping papers, themes, abstracts, sections of books, magazine articles, etc.

## 8. Methods of Evaluation & Schedule

- 8.1. Individual and class projects TBA -- Individuals are expected to produce at least one object cast from zinc ally and one object cast from aluminum alloy. While FPC has a number of stock patterns, the student is encouraged to create and cast their own objects which have included desk name plates, belt buckles, paper weights in the form of initials, ash trays, sun dials, chess pieces, and replacement parts for an antique engine. Please note the course/instructor specific notes at the end of this syllabus for limitations on the types of items that will be allowed.
- 8.2. A verity of methods will be used to evaluate the student's progress (and final grade) including oral and written tests, observation of class activities, and objects produced.
- 8.3. Testing/Evaluation Schedule TBA

## Attendance Policy

- 8.4. **NB** → While attendance in many college classes is optional, ***attendance in life and at work is not***, therefore **all participants are expected to attend all sessions**. *Please see the S.C.A.N.S. section below for additional discussion on this point.*
- 8.5. I do not waste my or the class's time by presenting unimportant or non-essential information, therefore **every class is important**.
- 8.6. **Much of the material is cumulative and sequential**, that is to understand material presented in class two it is essential that you attended class one.

- 8.7. Participation is an important part of life, and class participation is a significant element in student evaluation. If you do not attend, you can't participate. *Please see the S.C.A.N.S. section below for additional discussion on this point.*
- 8.8. It is assumed that you are participating in this class to obtain skills and knowledge. It is obvious that if you do not attend, you cannot obtain these skills and knowledge.
- 8.9. FPC has excellent relations and high credibility with the area employers. A major factor in this is that our graduates have traditionally exhibited high "on-the-job" performance consistent with the skills and knowledge described in the course syllabi. The only way to maintain these relationships and credibility is to insure that every student is presented with the opportunity to obtain these skills and knowledge, and verification of the acquisition of these skills and knowledge, which obviously requires class attendance.
- 8.10. One of the most valuable and enjoyable aspects of adult education is the sharing of knowledge and experiences among the participants. If you do not attend, you cannot contribute your unique experiences and observations. Thus, your absences affect not only your learning opportunities but also the learning opportunities of all the other participants, which includes the instructor.

## 9. SCANS<sup>2</sup> Workplace Competencies Addressed in this Class:

- 9.1. Resources: Identifies, organizes, plans, and allocates resources:
  - 9.1.1. Time--Selects goal-relevant activities, ranks them, allocates time, and prepares and follows schedules
  - 9.1.2. Money-- *[included for completeness but not used in this class]* Uses or prepares budgets, makes forecasts, keeps records, and makes adjustments to meet objectives
  - 9.1.3. Material and Facilities--Acquires, stores, allocates, and uses materials or space efficiently
  - 9.1.4. Human Resources--Assesses skills and distributes work accordingly, evaluates performance and provides feedback
- 9.2. Interpersonal: Works with others
  - 9.2.1. Participates as Member of a Team--contributes to group effort
  - 9.2.2. Teaches Others New Skills
  - 9.2.3. Serves Clients/Customers--works to satisfy customers' expectations
  - 9.2.4. Exercises Leadership--communicates ideas to justify position, persuades and convinces others
  - 9.2.5. Responsibly challenges existing procedures and policies
  - 9.2.6. Negotiates--works toward agreements involving exchange of resources, resolves divergent interests
  - 9.2.7. Works with Diversity--works well with men and women from diverse backgrounds
- 9.3. Information: Acquires and uses information
  - 9.3.1. Acquires and Evaluates Information
  - 9.3.2. Organizes and Maintains Information
  - 9.3.3. Interprets and Communicates Information
  - 9.3.4. Uses Computers to Process Information
- 9.4. Systems: Understands complex inter-relationships
  - 9.4.1. Understands Systems--knows how social, organizational, and technological systems work and operates effectively with them
  - 9.4.2. Monitors and Corrects Performance--distinguishes trends, predicts impacts on systems operations, diagnoses deviations in systems' performance and corrects malfunctions
  - 9.4.3. Improves or Designs Systems--suggests modifications to existing systems and develops new or alternative systems to improve performance
- 9.5. Technology: Works with a variety of technologies

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<sup>2</sup> Secretary's Commission on Achieving Necessary Skills  
See <http://pueblo.pc.maricopa.edu/MariMUSE/SCANS/SCANS.html> for details.

- 9.5.1. Selects Technology--chooses procedures, tools or equipment including computers and related technologies
- 9.5.2. Applies Technology to Task--Understands overall intent and proper procedures for setup and operation of equipment
- 9.5.3. Maintains and Troubleshoots Equipment--Prevents, identifies, or solves problems with equipment, including computers and other technologies

## 10. Next Recommended Course in Sequence: DNA

## 11. Frank Phillips College [FPC] General Policies:


- 11.1. **Assessment of Student Academic Achievement** - *Student learning is central to all that we do at the College.* Faculty assess student learning in a variety of ways, including in-course assessments, portfolios, certification examinations, employer surveys, transfer studies, and many others. The College measures its effectiveness through the results of our assessment of student learning and uses those results to improve student learning. **This two-way feedback is critical to our ongoing efforts to improve and expand our instructional efforts.**
- 11.2. **Students with Disabilities** - It is FPC's policy to provide reasonable accommodations to students with disabilities. Our goal is to help students succeed in this course. If you have a physical, mental, or learning disability and you need a reasonable accommodation to help you achieve success, please contact Becky Green Dean of Student Services (LIB 19 phone EXT 720). To best provide the accommodation you need, make this request as soon as possible, since **accommodations cannot be made to retroactively change a grade you have received for course work already completed.**
- 11.3. **Tutoring Services** - Tutoring services are available for most courses. These services are provided free of charge. Tutoring is provided by professional and student tutors. Tutor request cards are located at Student Services. For information, please call EXT 753.
- 11.4. **Course Withdrawal** - If for any reason you cannot complete this or any other course, you must officially withdraw from the class. Even if you never attend class, if you are officially enrolled in a course, you will receive a grade for the course unless you complete and submit a drop form with appropriate signatures to the registrar. If you have not completed all of the work, that grade can only be an F. Drop forms are available in the division office, in the counseling office, or from the registrar. After midterm, you must have the instructor's permission to withdraw from a class; therefore, his or her signature must be on the form before you submit it to the registrar. For the last date to withdraw without the signature of the instructor, check the quarterly/semester schedule. ***If you do decide to withdraw from a class and have any kind of scholarship or financial aid, you should consult with the financial aid office prior to the withdrawal to determine what, if any, effect it will have on your status<sup>3</sup>.***
- 11.5. **Incomplete Grade** - If you have been progressing satisfactorily in a course, but for reasons beyond your control (death in family, personal illness, etc.) you cannot complete all of the requirements for the course, you can request an incomplete grade (I) from the instructor. If the instructor agrees, you will work out a mutually agreeable completion schedule. The instructor will complete a grade change form once the course work is completed. If the grade change is not submitted by the Friday of the fifth week of the following term (fall for both spring and summer), the grade will automatically change to an F.
- 11.6. **Academic Dishonesty** - Using the ideas, expressions, writings, etc., of another person and representing them as your own is one form of academic dishonesty and can result in severe penalties, including failure on a project or in a course. Plagiarism includes not only word-for-word copying ***but also the use of the general ideas of another without giving appropriate credit to the source.***

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<sup>3</sup> For example, a change from enrollment for 12 or more semester credit hours [SCH] to less than 12 SCH is a change from full-time to part-time student classification which may affect scholarships, athletic eligibility, student loan category and draft status.

- 11.7. **General Conduct:** Students are responsible for knowing the Law and Order [General Conduct and Behavior] Regulations in the college catalog.
- 11.8. **Children in Classes:** Children are not allowed in classes without the *prior* approval of the instructor. If permission is granted to bring a child into a class, it is the parent's responsibility to see that the child in no way disturbs other students or the class in general. Even after permission is granted, the instructor has the right to ask a parent and child to leave a class if any kind of disruption takes place. Individuals who bring children to the college for any reason are expected to supervise them at all times.

12. **Course/Instructor Specific Notes:**

- 12.1. **There are no “small” accidents or “slight” injuries in a foundry.** →*ALL foundry [hot metal] work is dangerous* ← The fundamental reason for the excessive accident rates in commercial US foundries is the drive for high volume production resulting in a continual rush and the ignoring/circumventing of common-sense safe[ty] practices. **There are no production quotas at FPC.** **Safety will be practiced at all times. If it can't be done safely, it won't be done at FPC.**
- 12.2. At FPC ALL hot metal work and most molding/ramming up is a **two man operation at the minimum.** The materials used [sand and metal] are heavy, and when metal is molten it is highly dangerous. ***All hot metal operations [melting and pouring] must be done under the direct supervision of the instructor. Flipping or moving mold flasks with rammed sand larger than 6 inches by 6 inches by 4 inches [about 30 lbs] will be done by not less than two people,*** both to avoid dropping the filled flasks [and ruining the rammed sand mold and/or frame] and/or straining joints/muscles. If you have a compulsion to lift heavy weights and “throw your back out,” please do so at the BCAC, at work, or at home, not at the FPC foundry, especially not with a ladle or crucible full of 50 pounds of 900 degree molten metal.
- 12.3. Water in any form, such as soda, and molten metal cannot coexist and are likely to explode if mixed. Therefore, **any form of water such as water bottles, soda cans, etc. is absolutely forbidden within the foundry area when hot metal is present.**
- 12.4. The composition/condition of the red Petrobond molding sand is critical to successful sand casting. Therefore **nothing will be added to the sand** and every effort will be made to keep it clean and covered. If you chew or dip, get a spit cup and don't spit in the sand. (Cats are also not welcome in foundries for the same reason.)
- 12.5. One of the major causes of injuries in foundries are sand mullers [mixers]. Under no circumstances will anyone reach into the muller while it is operating. When it is necessary to reach into the muller, for example to remove all the sand after mulling, ***the operating switch on the machine must be locked out with the padlock provided.***
- 12.6.  Illegal items such as “brass knuckles” and/or immoral items such as lewd statues/figurines will **not** be manufactured in the FPC foundry. If you wouldn't want the Sheriff or your mother to see it, don't make it here.