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El Camino College
Industry Driven Regional Collaborative
For
Aerospace Manufacturing Engineering

Materials

Course Outline; Materials

This class is designed to introduce shop floor personnel, CAD designers, estimators, planners, purchasing agents, and low-and-mid level managers to materials, their properties, and manufacturing. Its' intent is to give basic data so that the individual will recognize the differences and handling requirements of varied materials that are commonly used in manufacturing.

This course will assist the student in preparation for certification as a Certified Manufacturing Technologist sponsored by the Society of Manufacturing Engineers.

Suggested Time; 24 hours (8 weeks @ 3 hours per week)
Suggested Credit; 1.5 semester units

In addition to the requirement of attending classes each student will be required to submit a 5-7 page paper on a manufacturing process of interest to the individual. The instructor must approve the subject matter. The student will be required to make a five minute presentation to the class on his chosen subject

This work is supported through a grant from the Chancellors Office of the California Community Colleges to the El Camino Community College District with assistance from the Small Manufacturers Institute.

Course Content:

1. Mechanical Properties and Metallurgy
2. Classification and Heat Treatment of Carbon, Low Alloy Steel, and Copper Based Alloys
3. Characteristics and Heat Treatment of Aluminum Alloys
4. Characteristics and Heat Treatment of Stainless Steels, Nickel Alloys, and Titanium Alloys
5. Fabrication, Machining, and Distortion Control of Materials
6. Processes, Equipment, and Heat Treating Quality Assurance
7. Non-Metalic Materials
8. Review of Course

Materials; Week 1

Mechanical Properties and Metallurgy

1) Mechanical Properties of Materials
    a. Brittleness
    b. Compressive Strength
    c. Creep
    d. Ductility
    e. Elastic Limit
    f. Elasticity
    g. Elongation
    h. Endurance Limit
    i. Fatigue Failure
    j. Fatigue Strength
    k. Hardness
    l. Impact Strength
    m. Load
    n. Malleability
    o. Mechanical Property
    p. Modulus of elasticity
    q. Notch Toughness
    r. Physical Property
    s. Plasticity
    t. Proportional Limit
    u. Strain
    v. Strength
    w. Stress
    x. Tensile Strength
    y. Toughness
    z. Ultimate Tensile Strength]
    aa. Yield Point
    bb. Yield Strength

2) Metallurgy
    a. Crystalline Structure
    b. Phase Diagrams
    c. Iron-Carbon Diagram
    d. Microstructure of Steel

Materials; Week 2

Classification and Heat Treatment of Carbon, Low Alloy Steel, and Copper Based Alloys

1) Classification
    a. Standard Steels
        i. Low Carbon
        ii. Medium Carbon
        iii. High Carbon
    b. Alloy Steels
        i. Low Alloy
        ii. High Alloy
    c. Specialty Steels (Tool)
        i. High Speed
        ii. Hot-Work
        iii. Cold-Work
        iv. Shock-Resistant
        v. Mold Steel
        vi. Specialty Tool Steels
        vii .Water-Hardening
    d. Cast-Ferris Alloys
        i. Cast Iron
        ii. Gray Iron
        iii. White Iron
        iv. Malleable
        v. Nodular
    e.Copper Alloys
        i. Copper
        ii. Brass
        iii. Bronze
2. Heat Treatment
    a. Annealing
        i. Full Annealing
        ii.Spheroidizing Annealing
        iii.Normalizing
        iv.Tempering
    b. Through Hardening
        i. Quenching
        ii. Martempering
        iii. Tempering
        iv. Austempering

c. Surface Hardening
    i. Carburizing
    ii. Cyaniding
    iii. Nitriding
    iv. Induction Hardening
    v. Flame Hardening

Materials; Week 3

Characteristics and Heat Treatment of Aluminum Alloys

1. Characteristics
    a. Non-Heat Treatable
    b. Heat Treatable
    c. Clad
    d. Oxides
    f. Fabrication
2. Aluminum alloys
    a. Aluminum
    b. Aluminum Alloys
    c. Casting Aluminum Alloys
3. Effects of Alloying Elements
    a. 1000 Series
    b. 2000 Series
    c. 3000 Series
    d. 4000 Series
    e. 5000 Series
    f. 6000 Series
    g. 7000 Series
4. Temper Designations
    a. F: Fabricated
    b. O: Annealed
    c. H: Strain Hardened
    d. W: Solution Heat-Treated
    e. T: Thermally Treated
5. Subdivisions of H Temper; Strain Hardened
    a. H1, H2, H3
6. Subdivisions of T Temper: thermally Treated
    a. T1
    b. T2
    c. T3
    d. T4
    e. T5
    f. T6
    g. T7
    h. T8
    i. T9
    j. T10

Materials; Week 4

Characteristics and Heat Treatment of Stainless Steels, Nickel Alloys, and Titanium alloys

Characteristics of Stainless Steels

- a. Martensitic Stainless Steels (400 Series)
  - i. Heat Treating
- b. Ferritic Stainless Steels (400 Series)
  - i. Heat Treating
- c. Austenitic Stainless Steels (200,300 Series)
  - i. Heat Treatment
- d. Precipitating-Hardening Stainless Steels (17-4,15-5, etc.)
  - i. Heat Treating

Characteristics of Nickel Based Alloys

- a. Maraging Steels (18 Ni., etc)
  - i. Heat Treatment
- b. Nickle Based Alloys (Hastalloy, Inconel, Monel, etc.)
  - i. Heat Treatment

Caharacteristics of Titanium Alloys

- a. Titanimum Alloys
  - i. Heat Treatment

Materials; Week 5

Fabrication, Machining, and Distortion Control of Materials

1.Carbon and Low Alloy Steels
   a. Fabrication
   b. Machining
   c. Distortion Control

2. Aluminum Alloys
   a. Fabrication
   b. Machining
   c. Distortion Control

3. Stainless Steels
   a. Fabrication
   b. Machining
   c. Distortion Control

4. Nickel Alloys
   a. Fabrication
   b. Machining
   c. Distortion Control

5. Titanium Alloys
   a. Fabrication
   b. Machining
   c. Distortion Control

Materials; Week 6

Processes, Equipment, and Heat Treating Quality Assurance

1. Processes
    a. Heating
        i. Furnace
        ii. Induction
        iii. Flame
    b. Quenching
        i. Oil
        ii. Water
        iii. Gas
        iv. Other

2. Equipment
    a. Furnaces
        i. Open
        ii. Modified Atmosphere
        iii. Conveyor, Automatic
    b. Quenching
        i. Design
        ii. Agitation
        iii. Spray

3. Masking
    a. Reasons and Methods

4. Fixturing
    a. Holding
    b. Distortion Control
    c. Growth
    d. Shrinkage

5. Quality Assurance
    a. Temperature Control of Equipment
    b. Surface Carbon Content
    c. Hardness Testing
    d. Process Control
    e. Microscopic Analysis
    f. Spectrographic Analysis

Materials; Week 7

Non-Metalic Materials

1. Plastics
    a. Polymer Structures
        i. Homopolymers
        ii. Copolymers
        iii.Terpolymers
    b. Thermoplastics
        i. Polyethylene
        ii.Polypropylene
        iii. Polyvinyl Chloride
        iv. Polystyrene
        v. Polyethylene Terephthalate
    c. Engineering Thermoplastics
        i. Nylon
        ii. Acetal
        iii.Polycarbonate
    d. Thermoset Plastics
        i. Rubber
        ii. Hard Thermosets

2. Composite Materials
    a. Construction – Matrix
    b. Fiber Types
    c. Composite Categories
    d. Composite Applications

3. Ceramics
    a. Structures
    b. Glass
    c. Advanced Ceramics
        i. Oxides
        ii. Carbides
        iii.Nitrides

4. Fabrication and Machining of Non-Metallic Materials
    a. Fabrication
    b. Machining
    c. Distortion control

Materials; Week 8

Review

Materials; Week 1
Mechanical Properties and Metallurgy

Materials; Week 2
Classification and Heat Treatment of Carbon, Low Alloy Steel, and Copper Based Alloys

Materials; Week 3
Characteristics and Heat Treatment of Aluminum Alloys

Materials; Week 4
Characteristics and Heat Treatment of Stainless Steels, Nickel Alloys, and Titanium alloys

Materials; Week 5
Fabrication, Machining, and Distortion Control of Materials

Materials; Week 6
Processes, Equipment, and Heat Treating Quality Assurance

Materials; Week 7
Non-Metalic Materials

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