NEW YORK CITY COLLEGE OF TECHNOLOGY  
DEPARTMENT OF RESTORATIVE DENTISTRY

COURSE CODE: RESD 2307
COURSE TITLE: THE SCIENCE OF DENTAL METALLURGY
COURSE DESCRIPTION: This course will consist of the study of dental metallurgy, physical and mechanical properties of metals, their internal structure, and types of precious and non-precious dental casting alloys and metals used in the laboratory. Also covered will be a discussion of soldering, welding, and casting procedures and the associated types of investments and equipment used in these procedures. Polishing agents used for metals will also be discussed.

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HOURS AND CREDITS: 1 lecture hour per week; 1 credit
NUMBER OF WEEKS: 15 Weeks
CURRICULUM LEVEL: Third semester
PREREQUISITES: RESD 1107
TEXTBOOKS:

REFERENCES:

Revised August 2017
COURSE REQUIREMENTS: Standard college and department attendance and grade regulations

ACADEMIC INTEGRITY: New York City College of Technology Policy on Academic Integrity
Students and all others who work with information, ideas, texts, images, music, inventions, and other intellectual property owe their audience and sources accuracy and honesty in using, crediting, and citing sources. As a community of intellectual and professional workers, the College recognizes its responsibility for providing instruction in information literacy and academic integrity, offering models of good practice, and responding vigilantly and appropriately to infractions of academic integrity. Accordingly, academic dishonesty is prohibited in The City University of New York and at New York City College of Technology and is punishable by penalties, including failing grades, suspension, and expulsion. The complete text of the College policy on Academic Integrity may be found in the catalog.

ACADEMIC DISHONESTY INCLUDING PLAGIARISM: Academic dishonesty is prohibited in the City University of New York and is punishable by penalties, including failing grades, suspension and expulsion.

Cheating is the unauthorized use or attempted use of material, information, notes, study aids, devices or communication with other students during an academic exercise, such as testing. Copying from another student during an examination or allowing another to copy your work.

❖ Cheating will not be tolerated during quizzes or exams, communication with anyone other than the instructor will be considered cheating. If you have questions during an examination quietly raise your hand and the instructor will come to your desk, or ask you to come up to their desk. There may be more than one version of an examination; if so the process will be the same.
❖ **Plagiarism** includes intentionally misrepresenting another person’s work, words, ideas, copying or stealing another person’s work and trying to pass it on as your own without giving proper credit to the originator.

**EVALUATION AND GRADING:**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Quiz</td>
<td>20%</td>
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<tr>
<td>Midterm</td>
<td>40%</td>
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<tr>
<td>Final Exam</td>
<td>40%</td>
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**Letter Grade**

- A = 93-100%
- A- = 90-92.9%
- B+ = 87-89.9%
- B = 83-86.9%
- B- = 80-82.9%
- C+ = 77-79.9%
- C = 70-76.9%
- D = 60-69.9%
- F = 59.9% and below

**ATTENDANCE POLICY:**

Attendance is expected for all class sessions. Failure to attend and be on-time for class sessions could result in missing important course information, missing graded activities which could result in below satisfactory scores to successfully meet degree requirements. A weighted course average of 70% or higher is required for this course to meet degree requirements.

**COORDINATOR:**

Professor Anthony Sena

REVISED – August 2017
RESD 2307 - SCIENCE OF DENTAL METALLURGY:

GOALS AND OBJECTIVES FOR RESD 2307 – The Science of Dental Metallurgy

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

1. List and describe the process of extraction, reduction and refinement of dental metals from ores

2. List and describe the physical properties of dental metals including, but not limited to, their color density, odor, thermal and electrical conductivity, melting and freezing points, tarnish resistance and thermal expansion

3. List and describe the mechanical properties of dental metals

4. List and define the ADA specifications of dental metals

5. List and describe the various dental alloys

6. List and describe the crystal structure and phase diagrams of dental metals

7. List and describe the characteristics and applications of various types of alloys

General Education Student Learning Objectives

1. Gain scientific knowledge of physical properties of matter. Understand phase diagrams and crystalline structures applications of these concepts.

2. Use reading skills to understand and interpret technical data.

3. Use and develop oral communication skills, building understanding of professional vocabulary, develop listening skills to interpret verbal directions. Practice verbal communication using appropriate professional terminology.
### Tentative course outline

Reading selections from: Dental Laboratory Technology, Air Force Pamphlet, 47-103, Vol. I & II
(A. F. manual readings are designated from Vol. I or Vol. II)
Philips’ Science of Dental Materials 12th ed. (Philips’)

<table>
<thead>
<tr>
<th>Topic</th>
<th>Reading</th>
<th>M section Date</th>
<th>Th section Date</th>
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<tbody>
<tr>
<td>1. Introduction to metallurgy</td>
<td>Vol. I p 61-63</td>
<td>Aug. 28</td>
<td>Aug. 31</td>
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<tr>
<td>2. Extraction of metals from ore</td>
<td></td>
<td>Sept.11</td>
<td>Sept. 7</td>
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<tr>
<td>3. Physical and mechanical properties of metals</td>
<td>Vol. I p 63-70; Craig’s Chapter 5</td>
<td>Sept 18</td>
<td>Sept. 14</td>
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<tr>
<td>5. Quiz</td>
<td></td>
<td>Oct. 2</td>
<td>Sept. 28</td>
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<tr>
<td>10. Implants</td>
<td>Vol. II pp. 196-200; Philips’ Chapter 20</td>
<td>Nov. 13</td>
<td>Nov. 2</td>
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<tr>
<td>11. Implants cont.</td>
<td></td>
<td>Nov. 20</td>
<td>Nov. 9</td>
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<tr>
<td>12. Polishing agents</td>
<td>Vol. II pp. 89-91; Philips’ Chapter 11</td>
<td>Nov. 27</td>
<td>Nov. 16</td>
</tr>
<tr>
<td>13. Ceramic metal systems</td>
<td>Vol. II, pp. 133-139; Philips’ Chapter 18</td>
<td>Dec. 4</td>
<td>Nov. 30</td>
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<td>15. Final</td>
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<td>Dec. 18</td>
<td>Dec. 14</td>
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Revised: August 2017
I. INTRODUCTION - ONE LECTURE HOUR

A. GENERAL GOALS OF COURSE

1. Student will be able to apply theoretical information and terminology to dental laboratory experience.
2. Demonstrate understanding of the theory during processes of dental laboratory work.
3. Analyze changes in working metals based on theory learned

B. DEFINITIONS: 1. metallurgy; 2. metal; 3. noble metal; 4. native metal, base metal; 6. Ores

II. EXTRACTION OF METALS FROM ORES - ONE LECTURE HOUR, Video, class handouts

III. PHYSICAL AND MECHANICAL PROPERTIES OF METALS – ONE LECTURE HOUR

1. Color
2. Density
3. Taste
4. Odor
5. thermal conductivity
6. specific heat
7. heat of fusion
8. electrical conductivity
9. thermal coefficient expansion
10. melting and freezing points
11. tarnish resistance (activity)
12. grain growth

IV. PHYSICAL AND MECHANICAL PROPERTIES OF METALS - ONE LECTURE HOUR

1. Force
2. Pressure
3. Stress
4. Strain
5. proportional limit
6. elastic limit
7. yield strength
8. ultimate strength
9. modulus of elasticity
10. malleability
11. ductility impact resistance
12. hardness tests
   a. Rockwell
   b. Brinell
   c. Bierbaum
   d. Knoop

V. QUIZ – Ores, Alloy Manufacturing

   1. high heat techniques
   2. low heat techniques
   3. casting defects
   4. investments, investment soldering
   5. free hand soldering
   6. spot welding

VII. MID-TERM – ONE LECTURE HOUR Mechanical Properties, casting, soldering, welding

VIII. DENTAL GOLD ALLOYS – ONE LECTURE HOUR
      Mechanical Properties Class handouts
      1. History
      2. Uses, Production, Consumption
      3. Measures of weight
      4. Alloy classifications

    1. origin
    2. types
    3. composition
    4. physical properties
    5. mechanical properties
    6. applications

   1. History
   2. Indications, Classification
   3. Implant materials
   4. Clinical training
   5. Clinical procedures
XI. Implant Video - CLINICAL AND LABORATORY PROCEDURES - ONE LECTURE HOUR
   1. Clinical considerations
   2. Types of implants
   3. Materials for implant manufacturer
   4. Clinical training
   5. Implant placement
   6. Crown placement on implants

XII. POLISHING AGENTS - ONE LECTURE HOUR - Air Force Manual, pp. 89-91
   1. Types of polishing agents
   2. Rough surface finishing
   3. Preliminary polishing
   4. Final polishing

   1. Composition
   2. Properties
   3. Ceramic restorations
   4. Sub-structure designs and considerations

XIV. COURSE REVIEW – ONE LECTURE HOUR

XV. FINAL EXAM - DURING LAST CLASS SESSION - ONE LECTURE HOUR CUMULATIVE
NEW YORK CITY COLLEGE OF TECHNOLOGY
DEPARTMENT OF RESTORATIVE DENTISTRY

INSTRUCTIONAL OBJECTIVES
RESD 2307 - THE SCIENCE OF DENTAL METALLURGY

I. INTRODUCTION TO DENTAL METALLURGY - ONE LECTURE HOUR
A. CONDITIONS: Given lectures and discussions on metallurgy and metals
B. PERFORMANCE: The student should be able to:
   1. Define the following terms: metallurgy, metal, noble metal, native metal, base metal and ore
   2. List properties that are characteristic of metals
C. EXTENT & CRITERIA: With at least 70% accuracy at the end of one lecture hour.

II. EXTRACTION OF METALS FROM ORES - ONE LECTURE HOUR
A. CONDITIONS: Given a lecture and discussion on the methods of extractions and refinement of metals from ore
B. PERFORMANCE: The student should be able to:
   - Define the following terms: concentration, magnetism, flotation, amalgamation, hydraulic concentration, reduction, and refining
C. EXTENT & CRITERIA: With at least 70% accuracy at the end of one lecture hour.

III. PHYSICAL AND MECHANICAL PROPERTIES OF METALS - ONE LECTURE HOUR
A. CONDITIONS: Given a lecture and discussions on various physical and mechanical properties of metals
B. PERFORMANCE: The student should be able to:
   1. Define the following terms and describe their significance to dental restorations and procedures: color, density, thermal conductivity, specific heat, heat of fusion, electrical conductivity, thermal coefficient expansion, melting and freezing points, tarnish resistance, grain growth.
   2. Name and describe coefficient of expansion.
C. EXTENT & CRITERIA: With at least 70% accuracy at the end of one lecture hour.

IV. PHYSICAL AND MECHANICAL PROPERTIES OF METALS ONE LECTURE HOUR
A. CONDITIONS: Given a lecture and discussion on physical and mechanical Properties of metals.

B. PERFORMANCE: The student should be able to:

Define the following terms and describe their significance to dental restorations and procedures: force, pressure, stress, strain, proportional limit, elastic limit, yield strength, ultimate strength, modulus of elasticity, malleability, ductility, impact resistance, hardness.

C. EXTENT & CRITERIA: With at least 70% accuracy at the end of one lecture hour.

V. QUIZ #1 - ONE LECTURE HOUR

VI. CASTING, SOLDERING AND WELDING PROCESSES - TWO LECTURE HOUR

A. CONDITIONS: Given a lecture and discussion on transparencies, and demonstrations on investment casting processes used in dental laboratory technology casting defects and methods of preventing these defects.

B. PERFORMANCE: The student should be able to:

1. List two types of investment materials used in casting dental alloys.
2. Cite two reasons for venting design.
3. Cite four casting defects and the methods of preventing the defects for gold alloys and vitallium alloys.
4. Differentiate between shrinkage and gas porosity.
5. List the steps in the procedure for a high heat and low heat casting technique and give the rationale for each step.
6. Identify the low medium and high carbon steel according to the carbon content.
7. List two purposes for each of the following heat treatments for steel alloys: annealing, normalizing, hardening, and tempering.
8. List two effects of tempering temperatures on the mechanical properties of a fully hardened alloy.
9. Describe four purposes for alloying steels.
10. Name two types of stainless steels and two applications for each type used in dental laboratory technology.
11. List three ingredients of amalgam and provide one reason for the presence of each ingredient.
12. Describe the effect of the ingredients on the compressive strength of the amalgam.

C. EXTENT & CRITERIA: With at least 70% accuracy at the end of two lecture hours.

VII. MIDTERM EXAM - ONE LECTURE HOUR
VIII. DENTAL GOLD ALLOYS- ONE LECTURE HOUR

A. CONDITIONS: Given a lecture and discussion on the carat and fineness of gold, the composition, properties and applications of four types of gold alloys, clasp gold, heat treatment of gold alloys, and gold solders

B. PERFORMANCE: The student should be able to:

1. Find the weight, percentage of gold and fineness in an alloy from the carat value
2. List two important properties and two applications for the four types of gold alloys according to ADA specification No. 5
3. Match the chemical composition and mechanical properties with the four types of gold alloys
4. List 3 constituents and two properties of a cast gold alloy
5. List the methods of production and properties ordered and disordered gold alloys
6. List two types of solders for gold alloys and name two applications for their use

C. EXTENT & CRITERIA: With at least 70% accuracy at the end of one lecture hour.

IX. BASE METAL CASTING ALLOYS - ONE LECTURE HOUR

A. CONDITIONS: Given a lecture and discussion on the origin, types, composition, uses, physical and chemical properties, methods of processing and repairing, trade names, and use of cobalt-chromium and base metal

B. PERFORMANCE: The student should be able to:

1. List four qualities of an alloy to be used for dental purposes
2. List three trade names of cobalt-chromium alloys
3. List the names of three elements and describe the reason for their addition in vitallium alloys
4. List three mechanical and physical properties and three applications of vitallium alloys
5. Name three other base metal alloys other than cobalt-chromium alloys and one application for each alloy used in dental technology

C. EXTENT & CRITERIA: With at least 70% accuracy at the end of one lecture hour.

X. IMPLANTS

A. CONDITIONS: Given a lecture and discussion on dental implants

B. PERFORMANCE: The student should be able to:
1. Discuss the history and evolution of modern day implants
2. Explain the indications for dental implants for a patient
3. Describe the different types of dental implants.
4. Discuss the advantages and disadvantages of implants
5. Discuss the clinical training for implants
6. Explain the surgical and laboratory procedures for implants

C. EXTENT & CRITERIA: With at least 70% accuracy at the end of one lecture hour.

XI. IMPLANT VIDEO

A. CONDITIONS: Given a video presentation and discussion on dental implants.

B. PERFORMANCE: The student should be able to:

1. Discuss the clinical criteria for dental implants
2. Explain the four bone categories for implant placement
3. Describe the surgical procedure for dental implants
4. Describe the laboratory procedures for dental implants
5. Explain importance of sterile environment for implant placement
6. Discuss implant maintenance by the patient
7. Discuss clinical training requirement for Dentists

C. EXTENT & CRITERIA: With at least 70% accuracy at the end of the one lecture hour

XII. POLISHING AGENTS - ONE LECTURE HOUR

A. CONDITIONS: Given a lecture and discussions on various polishing agents.

B. PERFORMANCE: The student should be able to:

1. Identify reasons for the finishing and polishing of restorations.
2. Describe various forms and types of abrasive and polishing agents and identify the material with which they are used.
3. Discuss polishing theory.
4. Discuss electro polishing.
5. Select the appropriate cleaning solution for removing various polishing agents from restorations

C. EXTENT & CRITERIA: With at least 70% accuracy at the end of one lecture hour.

XIII. CERAMIC METAL SYSTEMS - ONE LECTURE HOUR

A. CONDITIONS: Given a lecture and discussion on ceramic metal systems.

B. PERFORMANCE: The student should be able to:
1. Discuss ceramic metal systems with respect to their composition and properties.
2. Describe the advantages, disadvantages and limitations of ceramic restorations.

C. EXTENT & CRITERIA: With at least 70% accuracy at the end of one lecture hour.

XIV. FINAL REVIEW OF COURSE MATERIAL – ONE LECTURE HOUR

XV. FINAL EXAM DURING LAST CLASS SESSION - ONE LECTURE HOUR.