Florida Atlantic University  
Department of Civil, Environmental and Geomatics Engineering  
Engineering Scholars Program (ESP) 2015  

CGN 1500: Innovative Materials for Infrastructure  
3 credits  

1. Course Description and Prerequisites  
   Description: Introduction to New-generation, Innovative and Advanced Materials for Civil Infrastructure  
   Systems such as Bridges, Tall Structures, and Highway Pavements; Mix-Design and Mechanical  
   Properties; Environmentally Sound Concepts; Solid Waste Recycling, Green Building, and Sustainable  
   Development; Accelerated Testing and Long-Term Durability; Hands-on Laboratory Testing to determine  
   Engineering Properties.  

   Prerequisites: Algebra 2 and Biology  

2. Course Objectives (what we will do in this class)  
   A. Introduce emerging new materials for structures, bridges and highways  
   B. Introduce concepts of recycling, green building and sustainable development  
   C. Discuss the stress-strain-strength and durability properties of new materials  
   D. Provide hands-on laboratory testing experience for evaluating material properties  
   E. Teach how to use the material properties in simple design/construction modules  
   F. Discuss Infrastructure security and impact/blast resistant design  

3. Course Outcomes (what we expect you to learn)  
   1. Learn about various high-performance new materials in Civil Engineering construction  
   2. Understand the concept of Green Building and Sustainable Development  
   3. Learn how to characterize engineering materials for design applications  
   4. Ability to perform laboratory tests to determine mechanical properties  
   5. Ability to apply theoretical concepts into practical engineering design.  

4. Text Book (if required)  
   None  

5. Resources (needed/ to be provided)  
   Lecture notes and handouts posted on Blackboard (blackboard.fau.edu)  

   Recommended Reference Materials  
      Prentice Hall, 2006  

6. **Grading Scheme**

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
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<tbody>
<tr>
<td>7 Laboratory projects and Reports:</td>
<td>49%</td>
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<tr>
<td>1 Quiz:</td>
<td>10%</td>
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<tr>
<td>1 Group Research Report/presentation:</td>
<td>15%</td>
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<td><strong>Final Exam:</strong></td>
<td><strong>26%</strong></td>
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7. **Course Schedule Details**

**Monday, June 8**

**Morning**

**MODULE 1: Civil Engineering – Past, Present and Future**
Introduction and overview; What is Civil Engineering? American Society of Civil Engineers (ASCE); Code of ethics and professional conduct; Civil Engineering Infrastructure; Historical perspective; Current state of buildings, bridges and roadways; Need for Rehabilitation; Need for new high-performance materials.

**Afternoon**

**Laboratory Project 1: Grain Size Analysis of Recycled Crushed Concrete**
Introduction to testing machines; laboratory safety; alternative materials, sensors, and composites; Sieve analysis of demolition aggregate; technical report writing.

**Wednesday, June 10**

**Morning**

**MODULE 2: Civil Engineering Materials**
Introduction to Civil Engineering Materials; What are some of the new-generation materials? Smart Materials and Sensors; Alternative and recycled materials in civil engineering construction; Need for Alternative, High-Performance Materials; Environmental issues; Solid waste management issues; Sustainable development; Long-term durability issues.

**Afternoon**

**Laboratory Project 2: Concrete Mix Design using Recycled Aggregate (control specimen)**
Sample preparation, mix-design, and curing. **Lab 1 report due.**

**Friday, June 12**

**Morning**

**MODULE 3: Mechanics of Engineering Materials**
Concepts of stress, strain, strength and deformation; mechanics; mechanical testing; mechanical properties; failure analysis; ASTM standards; accelerated testing of long-term durability; theoretical formulations for predicting durability and performance; durability of recycled materials  QUIZ 1

Afternoon
Laboratory Project 3: Concrete Mix Design using Recycled Aggregate and Fly Ash or Rice Husk Ash as partial cement substitutes
Concrete made from construction and demolition (C&D) aggregate and fly ash; Sample preparation, mix-design, and curing.  Lab 2 report due.

Monday, June 15

Morning
MODULE 4: Science of Engineering Materials
Atomic arrangements and crystalline structure; lattice and unit cells; Miller Indices; defects and dislocations; Slip mechanisms and Schmid’s Law

Afternoon
Laboratory Project 4: Recycled Aggregate Concrete Reinforced with Post-Consumer HDPE Strips
Concrete made from C&D waste aggregate, fly ash and recycled plastic strips; sample preparation, mix-design and curing.  Lab 3 report due

Wednesday, June 17

Morning
MODULE 5: New-Generation Concrete
High-performance concrete; fiber-reinforced concrete; alternative fibers; concept of strength and toughness; unconventional materials in concrete; Fiber-reinforced plastics (FRP) for strengthening / retrofitting; recycled aggregate concrete
Assignment of Technical Research Paper

Afternoon
Laboratory Project 5: Compressive Strength Testing of Control Recycled Aggregate Concrete
Test control specimens from lab 2 under compression/tension.  Lab 4 report due.

Friday, June 19

Morning
MODULE 6: New-Generation Geo-Composites
Soils and geomaterials; shear strength and failure mechanisms; structural foundations; fiber-reinforced soil; recycled materials in geotechnical applications; geosynthetic reinforcement; bearing capacity of foundation soils

Afternoon
Laboratory Project 6: Compressive Strength Testing of FA and RHA Recycled Aggregate Concrete
Compressive strength testing of specimens from lab 3. Lab 5 report due.  QUIZ 2
Monday, June 22

Morning

**MODULE 7: Sustainable Development and Green Construction**
Soil and base stabilization with unconventional and recycled materials; Recycled plastics for soil reinforcement; Recycled aggregate from Construction and Demolition (C&D) wastes; sustainable, energy-efficient building walls

Afternoon

**Laboratory Project 7:** *Strength Testing of Recycled Aggregate Concrete containing HDPE recycled plastic reinforcement.*
Compressive strength testing of specimens from lab 3; Lab 6 report due.

Wednesday, June 24

Morning

**MODULE 8: Innovations in Solid Waste Management**
Vertical enhancement of existing landfill capacities; Significance of Piggyback Landfills in solid waste management practices; compressibility and settlement; Innovative geosynthetic reinforcement for slope stability; Compacted Clay Liners (CCL) and Geosynthetic Clay Liners (GCL)

Afternoon

**Laboratory Project 8:** *Research Project Activities*

Friday, June 26

Morning

**MODULE 9: Review, Discussions, Reflection / Meta-cognition; Comprehensive Final Exam**

Afternoon

**Presentation of Research Papers**

8. **Submission and Lab Usage Requirements**
   As described above

9. **Instructor and Contact Information**
   Dr. Khaled Sobhan
   Office: Room 221, BLDG. 36; Telephone: (561) 297-3473; Email: ksobhan@fau.edu

10. **Class Dates, Time and Location**
    MWF: 9:30 AM – 4:30 PM; Location: Lecture (TBA); Laboratory: EG 262

**For further information:** www.cege.fau.edu