Course Description
The course is designed to teach students about renewable energy and biofuels. The course covers the overview of available renewable energy options, their role in mitigating greenhouse gases, and deals in detail about the biofuels engineering. The course discusses about the biomass resources and their composition; types of biofuels; conversion technologies (thermochemical, supercritical water, and biochemical conversion processes); biodiesel from vegetable oils, algae to biofuels; economic and environmental assessments; and future R&D needs.

Evaluation Procedure: The student evaluations will rely more on homework, reports, seminar/presentation, and two class exams (mid-term and final). The course will require students to present a paper which can be on the general topic of biofuels or very specific targeting a single aspect of bioenergy.

Prerequisites
Major Professor’s Approval

Textbook(s) and/or Other Required Material
No single text book to adequately cover the entire course description. The class will focus on interactive discussion, reading literature articles, book chapters, websites, and handouts. Some of the reference books:


Reference Materials: USDA, USDOE, NREL, and other national laboratories biomass/biofuels reports, and critical reviews. Notes, handouts, and supplementary reading materials will be posted on blackboard.

Course Objectives
This is an applied course with an objective to develop basic understanding of renewable energy engineering and role of biofuels. After completion of this course, the students are expected to learn about:

(a) The current energy challenges and the importance biofuels in achieving energy security and minimizing greenhouse gases emissions;
(b) The overview of available renewable and alternative energy sources;
(c) Biomass resources, types of biofuels and the bio-refinery concept;
(d) Mass and energy balances, biomass characterization techniques, unit operations, and thermodynamics in biomass conversion process;
(e) The concept of 1st generation, 2nd generation, and advance biofuels;
(f) Techno-economic analysis of various biofuel conversion technologies and their environmental attributes; and
(g) The increasing role of renewable energy engineers to address growing energy needs.
(h) Energy literacy and workforce development.

### Topics Covered
Following topics will be covered:

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<tr>
<th>No.</th>
<th>Topics</th>
<th>Hours</th>
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<tbody>
<tr>
<td>1</td>
<td>Introduction, energy units, terminologies, energy security, and renewable energy sources</td>
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<td>2</td>
<td>Greenhouse Gases, Photosynthesis for Biofuels</td>
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<td>3</td>
<td>Types of biomass and available resources</td>
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<td>4</td>
<td>Lignocellulosic biomass composition and characterizations</td>
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<td>5</td>
<td>Pyrolysis, bio-oil upgradation, and biochar</td>
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<td>6</td>
<td>Biomass gasification followed by Fischer-Tropsch synthesis for liquid fuels</td>
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<td>7</td>
<td>Hydrothermal (sub- and supercritical water) technology for biofuels</td>
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<td>8</td>
<td>Biochemical Conversion Process, bioethanol production from 1st and 2nd generation biomass feedstock, biohydrogen, and methane</td>
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<td>9</td>
<td>Biopower, co-firing, biomass torrefaction and carbonization</td>
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<td>10</td>
<td>Biodiesel Process, vegetable oil sources and production, current technologies and challenges</td>
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<td>11</td>
<td>Algae to biofuels and challenges</td>
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<td>12</td>
<td>Biofuels laboratory visit and related Lab Exercises</td>
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<td>13</td>
<td>Biobased products, life cycle analysis, and water use in biofuels</td>
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<td>14</td>
<td>Biofuels economics, policies, and future R&amp;D</td>
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<td>Mid-term and final tests</td>
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### Class/Laboratory Schedule
One 150 minute lecture sessions per week.

### Computer Applications
Use of spreadsheet and word processor through homework

### Laboratory Projects
None

### Contribution of Course to Meeting the Professional Component
College-level mathematics and basic sciences: 0 credits
Engineering Topics: 3 credits
General education: 0 credits

**Relationship of Courses to Program Outcomes**

This course will enhance the student’s

(a) learning on multidisciplinary subjects and current issues related to energy engineering;
(b) understanding of renewable energy and their impact on societal and global context;
(c) ability to design experiments and conduct lab works pertinent to biofuel research;
(d) awareness of emerging technologies and their impact on environmental issues;
(e) ability to identify and formulate an engineering problem, collect relevant data, critically analyze and interpret data to develop a solution;
(f) ability to understand professional and ethical responsibility; and
(g) ability to work with multidisciplinary teams, present ideas and technical material to diverse audiences.
(h) preparation as energy literate workforce.

**Prepared by**
Sandeep Kumar

**Date of Preparation**
January 14, 2014