

San José State University
General Engineering
Eng 102 Renewable Energy Engineering
Fall 2009

Instructor:	Dr. Gleixner
Office Location:	Engineering 385
Telephone:	408-924-4051
Email:	gleixner@email.sjsu.edu
Office Hours:	Mon 9:30-11:30, Tu 9-10, 1:30-2:30, and Th 9-10
Class Days/Time:	Tu and Th 10:30-11:45 am in E401
Prerequisites:	For undergraduates only: CHEM 1A and (PHYS 71 or PHYS 52 or PHYS 2B); Upper division standing in engineering; graduate students require instructor consent

Course Description

Essentials of fluid dynamics and heat transfer. Solar thermal theory and applications. Photovoltaic generation. Biomass and biofuels. Fuel cells. Energy systems, generation and storage.

Course Goals

This course is in direct response to a new way of thinking in engineering. Engineering 102, aimed at upper-level undergraduate and entry-level graduate students, presents the fundamental engineering principles underlying renewable energy. This course is focused on sustainable energy conversion and storage. The prospect of producing clean, sustainable power from renewable energy sources is now raising interest worldwide. This has been stimulated by recent technological developments that have improved the cost-effectiveness of many of the renewable energy sources and by increasing concerns over the environmental impact and sustainability of traditional fossil fuels. Because of our location in Silicon Valley, the course will focus on the renewable energy sources most prevalent in California including solar energy, photovoltaics, rechargeable batteries, biofuels, and fuel cells. The course will also provide a broad overview of other renewable energy sources: wind, hydro, tidal, wave, and geothermal energy.

Textbooks

Renewable Energy Resources, 2nd edition, Twidell & Weir, Taylor & Francis Publishing, 2006.

Class Blackboard Site

This course will conduct all of its communications outside of class using Blackboard Learning System. All of the online resources including solutions to in class work, homework, and exams will be on Blackboard. To access the class site at Blackboard you must be enrolled in the course. Go to the <http://www.sjsu.edu/ecampus/students/>. The username, password, and login are on the right. On the left, there is a tutorial you haven't used Blackboard before.

Classroom Protocol

Silence all cell phones during the class period (you are rolling your eyes here...but let's count how many times they go off during the semester). Please arrive on time for class. I will collect all homework and assignments at the very start of class. If you are late to class, you will be marked down 10% on the assignment. Please hold all assignments to pass in to the end (it is very disruptive when you walk up and hand it to me during the floe of the class).

Dropping and Adding

Students are responsible for understanding the policies and procedures about add/drop, grade forgiveness, etc. Refer to the current semester's [Catalog Policies](http://info.sjsu.edu/static/catalog/policies.html) section at <http://info.sjsu.edu/static/catalog/policies.html>. Add/drop deadlines can be found on the [current academic calendar](http://www.sjsu.edu/academic_programs/calendars/academic_calendar/) web page located at http://www.sjsu.edu/academic_programs/calendars/academic_calendar/. The [Late Drop Policy](http://www.sjsu.edu/aars/policies/latedrops/policy/) is available at <http://www.sjsu.edu/aars/policies/latedrops/policy/>. Students should be aware of the current deadlines and penalties for dropping classes.

Information about the latest changes and news is available at the [Advising Hub](http://www.sjsu.edu/advising/) at <http://www.sjsu.edu/advising/>.

Assignments and Grading Policy

Course Element:	%
Homework	15%
Reading Assignments	5%
In-class Activities	5%
Blackboard Discussions	5%
Field Trips & Speakers	5%
Renewable Energy Project	20%
Midterm	20%
Final Exam	25%
Total	100%

Total Course Score	Letter Grade
97-100	A+
93-96	A
90-92	A-
87-89	B+
83-86	B
80-82	B-
77-79	C+
73-76	C
70-72	C-
60-69	D
< 60	F

In Class Activities

You will be actively involved in doing things during the class period. The general flow of each class period is that we will review what you worked on at home and the reading assignment, go over any questions that work sparked, work on harder applications of that material, and then wrap-up with any lingering questions. This flow can be very effective at ensuring you understand the material. However, it only works if come to class prepared! Do the reading and review last class's notes so that you can actively participate and get all your questions answered.

Homework and Reading Exercises

Homework must be submitted by the start of class period. If you are late to class or miss class, you can pass it in at the end of class or by the close of the day (5pm) for 10% off. If you have a legitimate, verifiable excuse such as travel for work or illness with a doctor's note, let me know and an alternative deadline will be agreed upon between us.

You are encouraged to work together on the assignments. However, you must pass in individual homework solutions. You are required to list the names of the students you worked with below your name in the upper right hand corner of your packet. Groups can be no larger than 3 students. If similar solutions are passed in by multiple students but they do not state they worked together, all the students will receive a 0 on that assignment.

You must have actively participated in solving everything you pass in and have a full understanding of the solution you submitted. Copying partial or complete answers from other students is unacceptable. *You will receive a 0 on the assignment and be reported to the University if you copy any portion of the homework or if you allow your homework to be copied. It is also a violation of the University academic honesty code to allow your work to be copied. You will receive a 0 on the assignment and be reported to the University if you allow your work to be copied.*

Test questions will target material learned through the homework. If you do not fully understand the solutions you pass in, you not only risk getting a 0 on that assignment but

you will not be able to answer the related questions during the tests. This will significantly affect your overall grade! **Come to office hours if you are having trouble doing the homework yourself.**

There will be a number of reading assignments throughout the semester. **They are most likely going to be due on Tuesdays every week. They are not listed on the course schedule so watch Blackboard for the assignments.** These assignments have a dual purpose of helping you gain the crucial information from the assigned textbook reading while teaching you some general skills to read more effectively.

Blackboard Discussions

We will be using the Blackboard discussion board to continue to learn and apply the material outside of class. All students are expected to participate in the discussions. To participate, you can post questions, answer other postings, or refer students to related links and applications you found. Full participation would be a minimum of five thoughtful postings over the course of the semester.

Field Trips & Speakers

We will have several field trips and speakers over the course of the semester related to engineering, economical, political, and environmental aspects of renewable energy in the Silicon Valley. For each trip or speaker, you will be asked to write a brief, 1 paragraph “Blog entry” on Blackboard. You will be given in advance of the trip or speaker the required content for the paragraph. You will be able to read and comment on your fellow students’ blogs so that you can all share ideas about what you found most valuable.

Renewable Energy Project

Over the course of the semester, you will be working in a group on a hands-on demonstration to teach a renewable energy type to middle school kids at McKinley School. There will be several milestones along the way to help you prepare your project.

Project Preference “Form” on Blackboard

Individual 1 page summary of renewable energy technology (10%)

Individual maximum 3 page summary of technical paper on Blackboard (20%)

Individual 1 page summary of teaching module concept (10%)

Group presentation of module at middle school (60%)

Turnitin.com

All project writing assignments must be uploaded to turnitin.com. Our course site info is class ID: **2814775**, enrollment password: **energy**

Examinations & Quizzes

There will be a midterm and a comprehensive final exam. Both tests will be open book, open notes. However, you will not have access to any electronic devices (other than a calculator) and you will not have access to the Blackboard site. You must bring a calculator to the examinations. To study for the tests, you should review the readings, course lecture notes, homework, and learning objectives well in advance of the test date.

University Policies

Academic integrity

Students should know that the University's [Academic Integrity Policy](http://sa.sjsu.edu/judicial_affairs/faculty_and_staff/academic_integrity/index.html) is available at http://sa.sjsu.edu/judicial_affairs/faculty_and_staff/academic_integrity/index.html. Your own commitment to learning, as evidenced by your enrollment at San Jose State University and the University's integrity policy, require you to be honest in all your academic course work. Faculty members are required to report all infractions to the office of Student Conduct and Ethical Development. The [Student Conduct and Ethical Development website](http://www.sa.sjsu.edu/judicial_affairs/index.html) is available at http://www.sa.sjsu.edu/judicial_affairs/index.html.

Instances of academic dishonesty will not be tolerated. Cheating on exams or plagiarism (presenting the work of another as your own, or the use of another person's ideas without giving proper credit) will result in a failing grade and sanctions by the University. For this class, all assignments are to be completed by the individual student unless otherwise specified. If you would like to include in your assignment any material you have submitted, or plan to submit for another class, please note that SJSU's Academic Policy F06-1 requires approval of instructors.

Campus Policy in Compliance with the American Disabilities Act

If you need course adaptations or accommodations because of a disability, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours. Presidential Directive 97-03 requires that students with disabilities requesting accommodations must register with the [Disability Resource Center](http://www.drc.sjsu.edu/) (DRC) at <http://www.drc.sjsu.edu/> to establish a record of their disability.

Student Technology Resources

Computer labs for student use are available in the Academic Success Center located on the 1st floor of Clark Hall and on the 2nd floor of the Student Union. Additional computer labs may be available in your department/college. Computers are also available in the Martin Luther King Library.

Engineering Student Success Center

Davidson College of Engineering Student Success Center (ESSC) assists undergraduate students in increasing their level of academic success and knowledge. In part, this is accomplished by helping students understand university requirements, policies, and procedures as well as by fostering a community of support. For more info, drop by E344 or see <http://www.engr.sjsu.edu/students/essc>

SJSU Writing Center

The SJSU Writing Center is located in Room 126 in Clark Hall. It is staffed by professional instructors and upper-division or graduate-level writing specialists from each of the seven SJSU colleges. Our writing specialists have met a rigorous GPA requirement, and they are well trained to assist all students at all levels within all disciplines to become better writers. The [Writing Center website](#) is located at

<http://www.sjsu.edu/writingcenter/about/staff/>. They offer **free** drop-in and by appointment writing sessions as well as workshops and online tutorials.

King Library

Most of all of you know of the library, but do you know of all it's hidden resources. You can reserve the small study rooms (great for group study work): <http://www.sjlibrary.org/services/rooms/>

There are a lot of tutorials online that are helpful on things like citing & writing, evaluating information, and search tips. Click on the side bar of this link: http://www.sjlibrary.org/services/literacy/info_comp/students.htm

Also, you can make an appointment with the engineering librarian to get help on searching and referencing. Their contact info is here: http://www.sjlibrary.org/about/contacts/sjsu_specialists.htm

Career Center

Be sure to register for the Career Center <http://careercenter.sjsu.edu/> . They have **free** workshops on resumes, interviewing, etc. You can make an appointment for a specialist to work on your resume with you. They have large internship and full time job fairs and an online job database.

Learning Assistance Resource Center

The Learning Assistance Resource Center (LARC) is located in Room 600 in the Student Services Center. It is designed to assist students in the development of their full academic potential and to motivate them to become self-directed learners. The center provides **free** support services, such as skills assessment, individual or group tutorials, subject advising, learning assistance, summer academic preparation and basic skills development. The [LARC website](http://www.sjsu.edu/larc/) is located at <http://www.sjsu.edu/larc/>.

Peer Mentor Center

The Peer Mentor Center is located on the 1st floor of Clark Hall in the Academic Success Center. The Peer Mentor Center is staffed with Peer Mentors who excel in helping students manage university life, tackling problems that range from academic challenges to interpersonal struggles. On the road to graduation, Peer Mentors are navigators, offering “roadside assistance” to peers who feel a bit lost or simply need help mapping out the locations of campus resources. Peer Mentor services are **free** and available on a drop –in basis, no reservation required. The [Peer Mentor Center website](http://www.sjsu.edu/muse/peermentor/) is located at <http://www.sjsu.edu/muse/peermentor/>

Student Health Center

The health center is free to all students for drop in or by appointment care. You can have an regular check-up or go with a specific question. (They do not handle emergencies. For emergencies, call 911 or campus police). They also have a number of health and wellness workshops. For hours and info, see: <http://www.sjsu.edu/studenthealth/>

Counseling Services

There is a free counseling service for students that takes both drop in and appointments. They handle the spectrum from depression, homesickness, stress, and academic study skills. Check out their services at: <http://www.sa.sjsu.edu/counseling/index.html>

Associates Students Site

The Associated students site (<http://as.sjsu.edu/>) hosts a range of resources including child care, recreation facilities, print shop, and transportation passes.

Student Clubs

SJSU has over 300 recognized student clubs. You can find an online directory of them here <http://www.sjsu.edu/getinvolved/> Also, the College of Engineering lists all their student clubs here <http://www.engr.sjsu.edu/students/organizations>

Budget Info

Please note that the facts in this section are completely accurate. However, the interpretation is my opinion and is not the official stance of SJSU or the CSU.

As you have noticed with your tuition bill, there have been dramatic changes in the CSU over the summer. SJSU has had a \$42 million dollar cut in the amount of support the campus receives from the state. That is 36% of the total state support the campus receives. This, simply put, is a lot of money and a very deep cut. It is unprecedented both in size and in the rapid timescale in which it was implemented.

The majority of the shortfall is being made up in two ways. First, as you know, students have a 30% fee increase from last year. This is following a steady stream of fee increases since 2003 that total 150%. The fee increase this year will result in increased revenue for the campus of \$18 million. Second, faculty and staff have been furloughed. This is a 9% pay cut with a reduction of work days during the academic year. This results in a one time savings to the campus of \$19 million dollars. The rest of the budget shortfall is being made up through general cuts in operations. The plan is to meet the future years' diminished budgets with a smaller campus: less students, classes, faculty, and staff.

It is important to note that the budget problems the CSU are having this year are not just due to a reduced state budget. There has been a dramatic shift, in just the short period of this summer, of who is funding public higher education in California. Over the last decade, the CSU system has consistently received about 3.4% of the state general budget. However, this year we will receive only 1.8%. That is, the CA state budget was dramatically reduced by the economy and on top of that, the CSU system got an even smaller percentage. With the shrinking budget, the Governor and legislature chose to meet other pressing needs by cutting the CSU more. I acknowledge that this must have been a very tough decision and that there are a lot of valuable services the state budget funds. However, the decision may have lasting consequences for the CSU. Over the last couple decades, the CSU budget was balanced with about 67% state support and 33% student fees. The primary reasoning behind this funding rational was that access to quality education to all was important to California's economy and society. Over this

summer, the balance on SJSU's campus shifted to 53% student fees and 47% state fees. As far as we know, this is not temporary. The CSU system has not been promised an increase in funding or even a return to the original percentage of the state budget. The SJSU campus will be moving forward to enhance our campus budget through increased research grants and innovative campaigns for alumni and industry support.

So, what can you do. If you do not agree in the shifting balance of how public education in CA is funded, I encourage you to email your legislators and the Governor. http://www.legislature.ca.gov/legislators_and_districts/legislators/your legislator.html
<http://gov.ca.gov/interact#contact>

I am sure the tuition increases were a significant hardship. This year has brought an increase in federal financial aid (<http://www.sjsu.edu/faso/>) as well as an increase to on-campus federal work study programs (<http://www.sjsu.edu/faso/typesofaid/federalworkstudy/>). I encourage you to investigate both of those. Also, SJSU has free counseling services that include stress management (<http://sa.sjsu.edu/counseling/index.html>).

Most importantly, I encourage you to not get caught in the trap of fixating on the negative. Revel in the fact that you are an important part of a great institution and are getting a great education. Be proud of how far you have come, what you are achieving, and where it will take you. I encourage you to get involved in the SJSU community. Utilize all the great resources the campus has to offer and truly excel in your education. Go on to do great things in society and prove that public education is a vital part of California's economy and society.

Furlough Details

The faculty and staff furlough days will impact your life here on campus, though every effort is being made to minimize that. Staff and administration furlough days are set by the University and are posted here. <http://www.sjsu.edu/hr/furlough/index.htm> Offices run by staff such as the registrar and the bursar will be closed those days. Campus police are not furloughed; the campus will have its normal protection on all days. Except for the overlap with the faculty furlough days discussed next, classes will be held on the staff furlough days.

Faculty are required to take nine furlough days. On those days, the faculty will not be on campus and in theory will not be working. You will not have class on those furlough days. The campus has set 3 of these faculty furlough days: Tu 9/22, M 10/19, and F 11/13. In addition, each faculty selects 6 other furlough days. Mine are M 8/31, W 9/9, W 10/14, Tu 11/24, F 12/4, and M 12/21.

This class will be cancelled for you on Tu 9/22 and Tu 11/24. In replace of class, I encourage (though not require) you to attend the College's Silicon Valley Leaders Symposium. These speakers are passionate, knowledgeable of their field, and very motivating. <http://www.engr.sjsu.edu/about/svls>

Course Schedule

Date	Lecture	Assignments	LOs
1: 8/25, 27	Introduction to Renewable Energy	Ch 1 & Ch 17	1-10
2: 9/1, 3	Measurements of Energy, Tour of SJSU Power Plant	Ch 1 & Ch 17, Th: Project preference form	1-10
3: 9/8, 10	Measurements of Solar Radiation	Ch 3 & 4, Th: HW 1	11-18
4: 9/15, 17	Solar Thermal, Tour of MAE's solar thermal lab	Ch 5 & 6	19-31
5: 9/22, 24	Tu: No class, furlough day Photovoltaics Fabrication	Ch 7, Th: HW 2	32-45
6: 9/29, 10/1	Photovoltaics Testing, Tour of Photovoltaic company	Ch 7, Th: Project: 1 page summary	32-45
7: 10/6, 8	Three Gorges Dam video, Hydro Power	Ch 2 & 8, Th: HW 3	46-51
8: 10/13, 15	Tu: Midterm Hydro Power	Tu: Midterm Ch 2 & 8	46-51
9: 10/ 20, 22	Wind	Ch 9, Th: Project: technical paper summary	52-61
10: 10/27, 29	Tu: Tour of biofeul company, Th: Biodiesel guest speaker	Ch 11, Th: HW 4	62-66
11: 11/3, 5	Fuel Cells	Th: Project module concept	67-69
12: 11/10, 12	Wave	Ch 12, Th: HW 5	70-76
13: 11/17, 19	Tidal Th: School Project	Ch 13, Th: School Project	77-84
14: 11/24, 26	No Class Tu & Th Furlough Day & Thanksgiving		
15: 12/2, 4	Geothermal	Ch 15	85-89
16: 12/8	Review	Tu: HW 6	
Cumulative Final: Mon Dec 14th, 9:45-12:00			

Eng 102 Learning Objectives

Students who complete all of the course assignments, including attending lectures, preparing homework problems, reading assignments, and completing student projects, should be able to...

Introduction to renewable energy

1. Define sustainable development.
2. Discuss the advantages and disadvantages of different renewable energy technologies.
3. Distinguish between dispersed and centralized renewable technologies.
4. Compare the energy consumption across different sectors in the US and internationally.
5. Compare the energy sources internationally.
6. Distinguish between force, energy, power, and intensity.
7. Analyze different renewable energy technologies based on simple economic models of kW/hr type of evaluation.
8. Identify both direct and external costs associated with each renewable technology.
9. Discuss factors causing global warming.
10. Design the best renewable energy option for an application factoring engineering, economic, political, and application specific constraints.

Measurements of Solar Radiation

11. Calculate declination, hour angle, and days of sunlight based on location.
12. Distinguish between different vectors of irradiance.
13. Calculate the irradiance on a surface based on location, geometry of surface, time of day and season.
14. Distinguish between irradiance and insolation.
15. List ways to measure solar irradiance.
16. List factors that influence actual solar radiance that are not accounted for in simple calculations.
17. Measure the solar irradiance.
18. Simulate the solar irradiance.

Solar Thermal

19. Distinguish between active and passive solar heating.
20. Compare different solar water heater designs including thoughts on cost, maintenance, and effectiveness.
21. Identify the influence of location effect (solar irradiance, outside temperature, wind speed) on effectiveness of water heater.
22. Distinguish between radiation, convection, and conduction and give examples in solar water heaters.
23. Calculate the convective heat transfer coefficient based on location and design.
24. Calculate the resistance to radiation and convection based on design and location.
25. Define absorptance, transmission, and emittance.
26. Evaluate the effectiveness of an insulator based on material and design constraints.
27. Calculate the time to heat a system or the maximum temperature based on design parameters and location.
28. Calculate the temperature change in a forced circulation system.

29. Discuss the advantages and disadvantages of using a concentrator.
30. Calculate the influence of a concentrator on the effectiveness of a water heater.
31. Design a water heater for a given application factoring in engineering, economic, and application specific constraints.

Photovoltaics

32. Measure the IV plots of a photovoltaic device.
33. Calculate the IV plot for a PV device.
34. Utilize physics of a pn junction to explain the IV plot for a PV device.
35. Label open circuit voltage, short circuit current, maximum power, and fill factor.
36. Describe how the properties of the cell change in series and parallel.
37. Define intrinsic, extrinsic, n-type and p-type semiconductor.
38. Describe the drift and diffusion of carriers across a junction.
39. Explain built in voltage and analyze what happens to it under different biases.
40. Calculate minority carrier lifetime and diffusion length of carriers and relate their significance to PV performance.
41. Analyze fabrication steps in a basic single crystalline Si PV device based on their importance for device performance.
42. Explain limitations on efficiency in PV devices.
43. Describe how a PV cell is designed to minimize loss.
44. Distinguish between first, second, and third generation PV technologies.
45. Design a PV array for a specific application and evaluate the limitations based on cost, location, etc.

Hydropower

46. Describe the advantages and disadvantages of hydropower from engineering, economical, environmental, and societal perspectives.
47. Draw a schematic of a hydropower plant, identify the purpose and challenges of each component.
48. Define head and flow and discuss ways they are measured.
49. Calculate the power produced from a hydropower plant.
50. Compare and contrast the different turbine options.
51. Design a Pelton wheel turbine system to maximize power for a given scenario.

Windpower

52. Describe the advantages and disadvantages of wind power from engineering, economical, environmental, and societal perspectives.
53. Describe the physical sources of wind on earth.
54. Calculate the power in the wind.
55. Draw the components of a wind turbine including specific dimensions and angles of the blade.
56. Compare and contrast different turbine designs.
57. Calculate the optimum speed and pitch of a blade.
58. Calculate the force (thrust), torque, and power of a HAWT system.
59. Calculate wind speed as a function of height.
60. Calculate the capacity factor.
61. Design a wind power system to maximize power for a given scenario.

Biomass and Biofuels

62. Describe the advantages and disadvantages of biomass and biofuels from engineering, economical, environmental, and societal perspectives.
63. List examples of biomass.
64. Classify biomass processes into categories: thermochemical, biochemical, and agrochemical (extraction). Compare and contrast the different processes in each category.
65. Calculate the heat of reaction, fuel consumed, and CO₂ produced for different combustion reactions.
66. Design an anaerobic digester to maximize power for a given scenario.

Fuel Cells

67. Describe the advantages and disadvantages of fuel cells from engineering, economical, environmental, and societal perspectives.
68. Define anode, cathode, and half cell reaction.
69. Describe different examples of fuel cells including the materials used to make them, the half cell reactions, fuel used, and by products created, and advantages and disadvantages of the system.

Wave Power

70. Describe the advantages and disadvantages of wave power from engineering, economical, environmental, and societal perspectives.
71. Describe the physical forces that cause waves on earth.
72. Compare and contrast different wave energy conversion technologies.
73. Calculate the amplitude, height, period, frequency, velocity, angular velocity, and power of a wave.
74. Describe methods of measuring and averaging the wave height and power.
75. Calculate the energy and power of a wave front and group of waves.
76. Design a wave power system to maximize power for a given scenario.

Tidal Power

77. Describe the advantages and disadvantages of tidal power from engineering, economical, environmental, and societal perspectives.
78. Describe the physical processes that cause tides on earth.
79. Label the components of a tidal power facility.
80. Describe factors to measure and average the height of a tide.
81. Calculate the power generated from a tidal site.
82. Describe resonance and calculate the size on an estuary needed for resonance.
83. Design a tidal current system.
84. Design a tidal power system to maximize power for a given scenario.

Geothermal

85. Describe the advantages and disadvantages of geothermal power from engineering, economical, environmental, and societal perspectives.
86. Describe the physical forces needed to create useable geothermal resources on earth.
87. List types of geothermal plants and their uses.
88. Calculate the heat transfer from hot dry rocks.
89. Calculate the transfer of heat from an aquifer.