

## Department of Civil Engineering Senior Design II – CE4288

### Instructor Contact Information and Biography

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**For class matters use Blackboard e-mail under the class communication tools.** I will repond to your emails within 24 business hours.

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#### About me:

I grew up in Guayanilla ([http://en.wikipedia.org/wiki/Guayanilla,\\_Puerto\\_Rico](http://en.wikipedia.org/wiki/Guayanilla,_Puerto_Rico)), a municipality of Puerto Rico, located on the southern coast of the island, bordering the Caribbean Sea, south of Adjuntas, east of Yauco; and west of Peñuelas and about 12 miles (20 km) west of Ponce, the 2nd largest city of Puerto



Rico. ([http://en.wikipedia.org/wiki/Ponce,\\_Puerto\\_Rico](http://en.wikipedia.org/wiki/Ponce,_Puerto_Rico)) (population <200,000).

I have a Bachelor's degree in Civil Engineering from the University of Puerto Rico at Mayaguez (UPRM), a Master's degree in Environmental Systems Engineering from Clemson University, and a Ph.D. in Civil Engineering, Specialized in Environmental Engineering, from New Mexico State University. In Puerto Rico, I was a professor in Civil Engineering at UPRM and worked in research (EPA, DOD, NSF) dealing with removal of contaminants from water using natural adsorbents, remote telemetry systems for monitoring of a small community drinking water treatment plant, physical modeling of transport of explosive related chemicals in sub-surface environments, and odor problems of combined sewer-overflows. I worked as consultant to the Comptroller of Puerto Rico as an auditor of the 10 largest water and wastewater treatment plants in Puerto Rico. I was part of the Puerto Rico Environmental Quality Board (PREQB) and Director of the Water Quality Area in the PREQB.



There is not enough space in this syllabus to explain why I left "paradise" for El Paso, but my family ended up here in 2006. Since August 2009, I have been at UTEP. I have taught courses in Environmental Engineering, Engineering Economy, Engineering Statics, Water and Wastewater Engineering, Capstone Senior Design Courses (I and II), Thermo-fluids, and Experimental Design. I can say I really have come to love UTEP and our students. I have found hard-working students that truly want to build a better future for themselves and their families.

## **A few things I want to share about this class**

### **Introduction**

This course is the culminating experience of your Civil Engineering College Education. This is where you will combine and put into practice your knowledge of structures, environmental, construction management, transportation, and geotechnical fields.

This capstone course meets ABET requirements while satisfying the needs of government, professional organizations, engineering companies, hiring companies, and universities seeking strong independent problem-solvers.

The Civil Engineering Department seeks feedback from our stakeholders, industry advisors, and employers to continuously improve our curriculum. Collectively, they all agree that we need to provide you, our students, with experience working in teams, professional communications, project, and time management skills with the purpose of solving Civil Engineering Design Problems.

During the first few weeks of the semester, there will be significant in-class interactive group activities. These are designed to help acquaint student teams with the project and with each other. Students are expected to actively learn and understand design concepts and methods. There will be little or no lecture, you will be working in teams throughout the semester.

Through the course, you will learn professional skills associated with effective technical oral and written communications, ethics, project management, and teamwork. We will use formative and summative assessment methods that can provide the necessary feedback for you to improve your skills.

Regular team meetings with and without your mentor, formal presentations, written reports, and site visits with clients and faculty will set the stage for you to develop your project ideas. Client approval will be a critical step to move forward in your design. Documentation is a necessary activity during the whole design process. You will be required to document your process and your progress using log books, blogs, discussion boards, or wikis.

### **Objectives of the Class (from TIDEE)**

The emphasis will be on developing your primary capabilities in the three categories of **design process, teamwork, and communication**. They include the following objectives.

#### **Objective 1: Design Process**

When assigned a significant design project, you will be able to manage, assess, and improve your design efforts to conceive, create, evaluate, and deliver a design to satisfy needs of a diverse set of clients.

#### **Objective 2: Teamwork**

When your team is given a collective responsibility, your team will be able to organize and develop a cohesive, energized team; plan, execute, critique, and improve team processes; and produce required deliverables within allotted resources.

#### **Objective 3: Communication**

**When you work in design teams, you will be able to establish and implement communication processes to effectively** record, critique, and exchange information inside and outside the team for quality performance and impact required of others.

Areas in particular that need significant developmental work are how to write problem definitions, develop managerial and planning skills, and how to effectively reach team decision or consensus.

Processes for making team decisions will be introduced that helps the team focus on issues rather than having someone with a strong personality or style of management control the decision making process.

Because this is a creative process, good oral and written communication is absolutely needed for the team to function effectively and produce imaginative solutions

### **What makes this course challenging?**

There are several reasons why the Senior Design courses pose the biggest challenge of your college career:

1. You will have to venture into new territory that is unfamiliar, unknown, and at times uncomfortable for you, such as immersion into city codes and regulations. There is no recipe, prescription, or right or wrong design, this will be real client-based **open-ended design**. Understandably, attacking real-world problems with only three years of college education and minimal consulting experience can be overwhelming for some of you. You will need to dig into your creativity and use the positive synergistic energy within your team.
2. You will need to work in teams. This project is impossible to be completed by one or two individuals, cooperation and willingness to work hard from every member of the group is vital for the success of the project.
3. You will need to plan dates of meetings and milestones. Time management is of the essence if you want to finish the project and still be sane the day of the final presentations.

### **What I believe about this class**

- 1) This class will be a challenge for most of you, but in the end it will be the most gratifying class you will have taken.
- 2) I am responsible for designing activities that challenge you and increase your understanding of the tasks you need to perform NOT of the technical material you should know.
- 3) Although I do my best to encourage and facilitate the successful completion of your project, no one else but you is ultimately responsible for making sure you complete it.
- 4) I will provide you feedback on how you are performing in the class through Blackboard, but likewise, I expect you to provide me with feedback on the effectiveness of the assignments, quizzes, and exams.

### **Capstone Student Role**

I have worked jointly with potential clients, including the City of El Paso, in the selection of projects that incorporate the areas of Civil Engineering that are offered at UTEP. It is up to you to make the project a success by committing to the following guidelines (Modified from EEIC):

1. As a team, create a team charter. Each individual team member agrees to a role and responsibility and a shared sense of purpose in pursuing a successful final project design
2. Establish a team leader and customer liaison
3. Perform professionally, especially when interfacing with the customer
4. Follow the design process with a focus on understanding the client's needs and meeting established benchmarks, including project deliverables
5. Create and adhere to a project schedule
6. Be a good team member and encourage others to be the same
7. Develop an understanding when to seek advice and assistance from project mentors and advisors, especially in the area of the resources to understand and solve the design problem
8. Hold effective team meetings
9. Keep a well-documented project notebook
10. Take extreme care in documenting and keeping private all potential intellectual property

11. Invest an average of a minimum of 10 hours/week on this project
12. Use time management skills to complete assigned tasks on time and with high quality
13. Attend all team meetings and company visits and be flexible with your schedule to allow for mutually convenient meeting times
14. Hold yourself and others accountable for your respective responsibilities
15. Participate in all formative assessment activities
16. Provide constructive feedback to the course instructor to improve the program
17. Participate in the final design presentation and possible Capstone Design Showcase event.

### **Capstone Project Mentor Role (modified from EEIC and RPI)**

Your project advisor (mentor) will serve the role of team coach. The primary responsibility is to provide overall guidance, direction, and support for the team. Mentors provide overall technical guidance, advise on professional development opportunities, and help make sure the project team has not overlooked important steps in the design process.

Advisors may be faculty members with experience working with teams or professional engineers with technical familiarity with the scope and work required by the design projects. Some guidelines for mentors which generally lead to a successful team project are:

1. Attend the kick-off student team meeting
  - a. Assist in keeping team realistic expectations and on track with the project scope.
  - b. Lead the discussion to define realistic project goals
  - c. Establish logistics for on-going meetings, progress reports, and presentations
2. Advise the student team
  - a. Help team assign roles
  - b. Coach the team in creating time line and define necessary tasks
  - c. Attend and advise students in status-review meetings
  - d. Attend final design presentation
  - e. At progress meetings, review past performance, future tasks, and hurdles. Assist when necessary hurdles arise that may detract from reaching the goal of completing a successful project design.
  - f. Coach the students in professional communications
3. Hold the student team accountable for their responsibilities
  - a. Review notes and/or unnecessary delays in meeting project deadlines
  - b. Review and approve technical drawings and specifications
4. Grade the team's overall performance and value individual contribution
  - a. Overall progress in understanding the design process and applying their knowledge and skills to the project.
  - b. Personal commitment to achieve results and contribute to team effort
  - c. Written reports
  - d. Quality of the final design
5. Help improve team effectiveness
  - a. Promote consistent communication guidelines (written and oral)

- b. Foster team building, leadership, and interpersonal skills within the team

***It is important for mentors to understand that this is a student project and that they act as coaches. It is important NOT to become the lead designer but to encourage students to seek their own resources of knowledge and create their own solutions.***

### Documentation

An ongoing record (Project Notebook) of the project will be maintained in either hard copy or electronic form. Documentation will include all submitted assignments, meeting minutes, decisions, results, technical documentation, trip visit, summary reports, etc.

### **Why a Project Notebook? (in senior design 1 you practiced this)**

Engineers are often involved in documenting project development and processes. As such, a journal will be an important tool for your academic and professional development. A journal or logbook allows you to reflect back upon recorded data and information when needed. Learning to document your actions will serve you well in your future career. This class begins the habit of journaling.

### **Initial Rules for Team Projects Notebooks**

- Rotate the responsibility to make entries among team members.
- Record every team meeting: date, time, location, attendees, what was discussed, ideas and who had them, decisions made, and assignments.
- Also record work completed outside of meetings.
- Record in writing, but also paste in sketches, data sheets, evaluation forms, etc.
- Record the team part of homework assignments.
- Record the work of your team so a reviewer can understand it.

### **Assignments**

Written documents should follow the format in the respective assignment description.

### **Oral Presentations**

Typically, presentations are in PowerPoint or Prezi (not recommended). Presentations on design project must be reviewed by the team's mentor(s).

Floor plan and Site Plan presentation to architect will be held within the next two weeks.

### **Final Written Report**

Final written report is a formal design document and it should not have more than 20 pages, double spaced, 12-point font. It should include the following parts:

1. Executive summary
2. Introduction
3. Background (Problem definition/Specification)
  - a. Design considerations
4. Design (include drawings and discussions)
  - a. Site plan
  - b. Floor plan
  - c. Structural

- d. Transportation (including pavement design)
  - e. Geotechnical
  - f. Environmental (LEED certification, storm water retention plan, and Environmental Phase I)
  - g. Construction Management (schedule and cost)
5. Conclusion (including socio-economic impacts)
  6. Bibliography

All figures and drawings must be contained within the 20 page limit. Appendices are for showing results of research or supporting technical documentation.

### Course Resources

#### Textbook

The textbooks used in previous courses are often useful as references. Students are required to research and collect information relevant to the assigned project.

#### References:

You will need to apply your technical knowledge and learn to find and understand codes and regulations that are applicable to your project. There some of the documents you will need to revise in addition to the 2015 IBC:

- City of El Paso Smart Code ([http://www.planelpaso.org/wp-content/reports/SmartCode\\_presentation-to-Council\\_20July.pdf](http://www.planelpaso.org/wp-content/reports/SmartCode_presentation-to-Council_20July.pdf))
  - The Smart Code as of today, is optional, but for new City projects is a requirement. For the designs in this class Smart Code will be required. The Smart Code supersedes the IBC regarding site planning.
  - Smart code is available free of cost at : <http://www.ci.el-paso.tx.us/documents/SmartCode%20Adopted%2029%20July%202008.pdf>
- Other City codes
  - [https://www.municode.com/library/tx/el\\_paso/codes/code\\_of\\_ordinances](https://www.municode.com/library/tx/el_paso/codes/code_of_ordinances)
- LEED (Leadership in Energy and Environmental Design) documentation developed by the US Green Building Council (USGBC)
  - <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1988>
- Green Globes
  - <http://www.greenglobes.com/home.asp>
- Other applicable codes in steel and concrete design, transportation, and environmental issues.

#### Software that you can use

All faculty, staff, and students of UTEP are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator.

1. You can use <http://doodle.com/> to facilitate the scheduling process
2. Bentley has lots of Civil Engineering Software - from buildings to bridges, transit to utilities, clean energy to clean water. The CE Alumni has paid enough licenses for all of the students enrolled in the Senior Design courses. Go to <https://my.apps.utep.edu> and you will find it under the Engineering apps.

3. You can use free EPA models for hydrologic analysis (<http://www.epa.gov/athens/wwqtsc/html/swmm.html> ) such as SWMM or Corps of Engineers (<http://www.hec.usace.army.mil/software/> ) such as HEC-HMS. The important consideration is that whatever model you use, you understand how it works and why is applicable to your specific conditions.
4. You can use Primavera or Microsoft Project.

### **Blackboard**

Homeworks, progress reports, and presentations, research papers, and other materials will be submitted through the Blackboard course site.

### **How do you earn your grade?**

The assessments serve to give you valuable feedback about how well you are achieving the learning objectives. The assessments are “forward looking.”

### **Individual Grade Components**

**Individual or group homework or presentations:** Homework must be submitted during the scheduled class period to receive full credit. Homework must be submitted in class on the due date to be considered on-time. **I-Peer teamwork** behavior evaluation: one or two semester online evaluations of each team mate (including yourself) will be conducted during the semester, because it is important in this class to let your team mates know how they are performing as a part of the team.

**Exams:** No exams will be given

**Oral Presentations:** On proposed design, ethical and professional issues and final design

**Attendance:** Design is not a spectator sport. Active in-class and out of class participation is required. You are expected to be on time to class, to meetings with your mentor and project team. You must always be prepared for short impromptu presentation of your work during the semester and this may affect your group grade.

Additionally, University policy dictates that all students attend all scheduled classes. Attendance can be checked randomly, and not necessarily in every class, by the instructor through sign-up sheets, exams, roll calling, randomly picked names for problem solving in class, Socrates, or other mechanisms. The instructor appreciates all efforts to attend the class. **YOU AND ONLY YOU ARE RESPONSIBLE FOR SIGNING ATTENDANCE SHEETS, WHEN PASSED AROUND THE CLASS.**

**Grading**

Description	Content	Percent of Final Grade
Attendance	Attendance to all classes and scheduled seminars or presentations (10%) (Individual grade). If you don't have any absence, you get 5% If you have two: 4% If you have more than two but less than four (included): 3% If you have more than four absences, but less than six (included): 1% If you have more than six absences, you may get an F in the class.	5%
Peer Evaluation	Members of your group will evaluate you based on attendance to meetings, participation, and contribution to group design project (at midterm and final of semester)	15%
Written reports, Oral presentations, reports, class participation	In-class presentations on technical and ethical issues, ethics, progress reports, and project notebook (journal) (Grade per group)	15%
Project notebook	You will have bi-weekly revisions of your project notebook that you will keep on Blackboard using the Journal tool.	5%
Final Written Report signed by mentors, and final presentation	Turn in Final presentation and report on BB in both word or power point and pdf formats.	<b>60% (30% for final report and 30% for final presentation)</b>

**Grade Distribution**

The grade is determined by “project success”, which is defined as how well the project results meet the needs of the customer. At the same time, consideration is given to the process of achieving success such as meeting schedules, planning, and initiative (RPI). Your final grade will be calculated based on the points you have accumulated as follows:

Letter Grade	Grade	Performance Characteristic
A	<u>&gt;89.5</u>	Outstanding-must demonstrate initiative, self-motivation, and go beyond what is asked
B	<u>&gt;79.5</u> but <89.5	Above average-all assignments and tasks were done on time and done correctly
C	<u>&gt;69.5</u> but <79.5	Average-work done on time but shows lack of initiative
D	<u>&gt;59.5</u> but <69.5	Below average-work is late, only partially fulfills requirements and shows no initiative
F	<59.5	Failing grade-work missing and does not fulfill requirements

Note that 89.44 is B, 79.44 is C, 69.44 is D, 59.44 is F. This is where your bonus points come to your rescue!

The instructor reserves the right to revise this grading plan. However, students will be informed of any changes.

**Time Management**

Deadlines for all assignments and tasks will be posted on BB. One of your tasks is to develop a Time Management Plan for yourself and your team. This means that you will:

- 1) Create a weekly calendar containing you class times, your work times, your family activities, your breakfast, lunch and dinner activities, your physical activities and exercise, time to go shopping, etc.
- 2) Create a semester calendar for including the months of August, September, October, November, and December, in which you enter your weekly activities and the quizzes and exams for each of your courses. Create your plan and stick to it!!

### **Class Policies**

Purpose: These policies serve to help make the learning experience optimally effective and enjoyable for everyone.

#### **Professional conduct**

During this course, I expect you to deal with your peers and with me in a professional manner. Be courteous and honest and always communicate with each other in a way that shows respect and sensitivity to gender, cultural, religious, sexual, and other individual differences. I expect you to come to class on time and stay focused on the lecture and learning activities.

Additionally, students should represent themselves in a professional manner in forums that have public access (Facebook, twitter,..). Information on these pages is often screened by potential employers, and un-professional material can have a negative impact on job or graduate school prospects.

Any form of sexual harassment or intimidation will NOT be tolerated. Policies are available on the UTEP web page. When a complaint is received, the situation will be investigated by the Office of Student Life and possible by the police, even if the harassment was done anonymously or possibly as a joke. Being found guilty of harassment is likely to be professionally damaging.

#### **Cell Phones are OFF in Class**

First, professionals turn off their phone ringers in a meeting with other professionals in order to give full attention to the discussion. Second, a ringing phone disrupts because the sound of a phone attracts attention. Disruptions of the learning process are annoying. Your meeting time in class is valuable, chat and text with your friends outside of your team meeting. **Turn your cell phone off and put it in your backpack .**

#### **Use of Laptops**

I do not mind you using your laptop in class, except when it disrupts the learning process. I will not accept surfing the internet on topics not related to your class activities, or answering your email, instant messaging, chatting, video viewing, music playing, game playing, etc. This activity show a lack of respect for your classmates and myself, and also shows a disinterest in the course which is un-professional and un-acceptable. If you do, you will no longer be allowed to use your laptop in class. A few suggestions that will help the use of laptops in class:

1. Charge your laptop batteries fully before coming to class.
2. Set your laptop volume control to mute or off before coming to class.
3. Keep your laptop closed during presentations and other specific in-class activities.

#### **Cheating, Plagiarism, Scholastic Dishonesty, and Student Discipline**

Cheating is unethical and not acceptable. Plagiarism is using information or original wording in a paper without giving credit to the source of that information or wording; it is also not acceptable. Do not submit work under your name that you did not do yourself, ever. You may not submit work for this class that you did for another class. If you cheated or plagiarized, you will be subject to disciplinary action as stated in the UTEP undergraduate catalog policy.

*“Scholastic dishonesty (which includes the attempt of any student to present the work of another as his or her own, or any work which s(he) has not honestly performed, or attempting to pass any examination by improper means) is a serious offense and will subject the student to disciplinary action. The aiding and abetting of a student in any dishonesty is held to be an equally serious offense. All alleged acts of scholastic dishonesty should be reported to the Dean of Students for disposition. It is the Dean of Students’ responsibility to investigate each allegation, dismiss the allegation, or proceed with disciplinary action in a manner which provides the accused student his or her rights of due process.”*

Refer to <http://www.utep.edu/dos/acadintg.htm> for further information.

You must cite, reference, or quote information obtained from other sources so you give credit where credit is due. If you do not know how to do that, ask. In addition, when an assignment specifies that you must perform a task individually, asking for your classmates’ help is scholastic dishonesty. Do NOT copy any material, regardless of where you obtained it, into your own work. Do NOT submit work under your name if you did not complete it entirely yourself; be honest and tell me you did it together. The consequences will be less severe when you are up front about it than when you try to hide it.

UTEP now has a site license for Turnitin.com, a plagiarism detection tool that you can also use to check your own work for this or other classes to prevent getting in trouble. I will report any instances of plagiarism and dishonesty to the Dean of Students Office and the grade for the assignment will be an “F” or “zero”.

If you want to test your understanding of plagiarism, take the self-assessment at <http://education.indiana.edu/~frick/plagiarism> or visit <http://www.turnitin.com>

### **Students with Any Type of Disability**

UTEP seeks to provide reasonable accommodations for all qualified individuals with disabilities, including learning disabilities. This university will adhere to all applicable federal, state, and local laws, regulations and guidelines with respect to providing reasonable accommodations as required affording equal educational opportunity. It is the student's responsibility to register with Center for Accomodation and Support Services (CASS) in the East Union Bldg., Room 106 within the first two weeks of classes, and inform the faculty member to arrange for appropriate accommodations.

**Center for Accomodation and Support Services (CASS) can also be reached in the following ways:**

**Web:** <http://sa.utep.edu/cass/>

**Monday thru Friday 8:00a.m.-5:00p.m.**

**Phone:(915) 747-5148**

**Union Building East Room 106**

[cass@utep.edu](mailto:cass@utep.edu)

**Tentative schedule of topics**

<b>Week</b>	<b>Topics covered</b>
1	Introduction and Syllabus-Expectations and team assessment
2	Presentation to Laura Foster, Chief Architect, City of El Paso
3	Guest Speaker
4	Guest Speaker and/or class-Technical writing
5	1 <sup>st</sup> Preliminary report due-Friday September 29 <sup>th</sup> no class
6	Guest Speaker/and or class-technical presentations
7	Guest Speaker/and or class-prepare short technical presentation on topic provided/upload presentation at the end of class
8	Elevator pitch 2 <sup>nd</sup> preliminary report due October 16 <sup>th</sup>
9	Guest Speaker
10	Guest Speaker
11	Draft of <b>final</b> reports due-each group will meet with Dr. Santiago to go over reports
12	Guest speaker
13	Final reports due by Tuesday November 21 <sup>st</sup> Thanksgiving break (November 23 <sup>rd</sup> and 24 <sup>th</sup> )
14	Mock Presentations
15	Final Presentations December 7 <sup>th</sup> at 10:30 am Business 319

**NOTE: Unexpected events such as availability of guest speakers, may necessitate changes in the course schedule, policies, and assignments. If feedback indicates that change may improve your learning experiences, such change will be made only upon mutual agreement between the instructors and the students.**

## Food for Thought: Profile of a Top Quality Engineer

Engineers at the top of their profession often exhibit similar characteristics. A recent survey of engineers catalogued several traits commonly found in engineers performing at a high-level within industry. **Results-Driven**—Accepts responsibility; maintains focus and acts with urgency to complete important tasks amidst multiple demands; takes necessary initiative and appropriate risks to overcome obstacles and achieve objectives

**Technically Competence**—Properly applies knowledge, methods, and state-of-the-art tools of engineering to analyze and solve engineering problems; capable in fundamentals of mathematics, statistics, physical and life sciences, engineering sciences, experimental methods, engineering economics, and information technology

**Engineering Judgment**—Thinks critically to recognize and understand crucial questions, draws evaluation criteria from diverse sources, evaluates multiple alternatives against established criteria and associated risks, makes vital judgments, and checks viability of decisions

**Creativity and Innovation**—Thinks creatively (independently and cooperatively) and searches broadly to identify and formulate innovative approaches; models and supports conduct that enhances creativity

**Client-Oriented Quality Improvement**—Establishes successful relationships with internal and external clients to understand and anticipate their needs (definitions of quality); achieves or exceeds agreed-upon quality standards; measures achievement, identifies root causes of problems, and revises processes for continuous improvement

**Business Orientation**—Understands the factors that drive business success in today's marketplace; adapts efforts to appropriately support the changing business needs of the organization for which work is done

**Responsible Engineering**—Design, produce, and employ engineering products and processes within the context of global, societal, environmental, and organizational constraints; use technologies constructively to protect society and to mitigate undesirable impacts

**Ethics and Professionalism**—Exhibits integrity and ethical behavior in engineering practice and relationships; participates in discipline-appropriate professional societies to establish standards and ensure that engineers comply with professional codes and standards

**Team Performance**—Respects and works effectively with diverse people; builds and maintains productive working relationships; resolves conflicts productively; performs as a trustworthy team player; encourages, assists, and rewards individual and team successes; capitalizes on diverse expertise and perspectives

**Professional Development**—Anticipates change, remains flexible, and applies ongoing self-assessment, planning, and effort to continue to grow professionally and deal constructively with changes in the organization and society; helps others grow professionally and respond to change

**Communication**—Listens and observes attentively and effectively to assess audience information needs; organizes and expresses thoughts clearly and concisely, both in speaking and writing, with necessary supporting materials to achieve desired understanding and impact; keeps stakeholders informed about matters that affect their work; protects confidentiality

<http://www.tidee.wsu.edu/resources/curriculum-materials/documents/f/unit1/Session1-TheMakingofanEngineer.pdf>